

A Miocene Flora from Thorn Creek, Idaho

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The Thorn Creek locality is on the southern edge of the Boise (or Idaho) Basin. The fossiliferous strata were discovered by members of a Civilian Conservation Corps in the fall of 1937, and were exposed in a road-cut about one mile up from the mouth of the creek in Sec. 30, T. 5 N., R. 5 E. approximately ten miles south of Idaho City, Boise County, Idaho.

The plant impressions proved to be extremely well preserved. Collections were made for me in 1937 and 1938 by Orma J. Smith and H. M. Tucker of the College of Idaho. I made fairly large collections in 1937 and again in 1939. Between 1937 and August 1939 a large amount of material above the fossil bed was removed by a landslide leaving a broad exposure. In this new exposure we found only a few additional species, indicating that a representative collection had very likely been obtained.

I acknowledge with thanks the interest of Dean Orma J. Smith and Professor H. M. Tucker and the collections they made for me; and of Professor E. B. Mains who made available the collections of the University of Michigan Herbarium.

The most extensive general study of the Boise Basin is that of Lindgren (25). More recent work has been done by Jones (17) and Ballard (4). Lindgren collected plant fossils from five localities, one of which was in the basin and the others along Boise Ridge which divides the basin from the Payette River drainage. Knowlton (21) studied the plant impressions from Lindgren's collections and identified thirty-two species, seventeen of which he described as new. Lindgren (25) proposed the name Payette formation for the lacustrine sediments of that area. In 1900 he (26) reported additional plant remains from this formation at Sucker Creek, a small stream on the west side of the Owyhee Mountains of Idaho about fifty miles southwest of the Thorn Creek locality. Lake beds mapped as belonging to the Payette formation occupy an area of about seven square miles near Idaho City. They occur on both sides of Moore Creek about a half mile below Warm Springs and ten miles north of Thorn Creek. They consist of partially consolidated white sand and clay. Fossil plants collected by Lindgren from these beds included the following: *Equisetum*, *Pinus* fruit, *Sequoia angustifolia*?, *Ulmus speciosa*, *Celastrus Lindgreni*, and *Trapa americana*.

With the exception of my preliminary report (34) on some of the Thorn Creek fossils, no further paleobotanical studies seem to have been made in the

Boise Basin-Boise Ridge region. A number of investigations have been made at Sucker Creek and in the vicinity of Weiser, Idaho. Chaney (13), Berry (7), Brooks (9), Arnold (1, 2, 3) and Smith (32, 33, 35) have studied the Sucker Creek flora. Fossils from the Weiser beds have been studied by Berry (8), Dorf (16) and Smith (31). As a result of these studies and Kirkham's work (18), the plant-bearing strata of southwestern Idaho and adjacent Oregon have been divided into two series, the (older) Payette and the (younger) Idaho formation. Kirkham (18) has presented evidence for a Miocene age for the Payette and transitional or early Pliocene age for the Idaho formation.

The Boise Basin is a roughly circular area lying in the south central part of the Central Province of the Rocky Mountain System. It constitutes the drainage area of Moore Creek and Grimes Creek and is about fifteen miles in diameter. The floor at Idaho City has an elevation of 4000 feet. The basin is sharply separated from the surrounding country by the high divides of the Boise Mountains and irregular spurs of the Sawtooth Range which attain elevations of nearly 8000 feet.

The geologic succession of events in the basin is not well established. According to Lindgren (25) erosion alone would not have produced the basin, but must have been accompanied by block faulting. He believed that the Miocene sediments of the basins of southwestern Idaho were deposited in a large lake, Lake Payette. Kirkham (18) who has done more recent work, does not envisage a single large lake as being responsible for all this deposition. He suggests that streams, fans, deltas and small temporary lakes may have played a part as depositing agencies.

It is probable that the climatic conditions at Thorn Creek are almost the same as those at Garden Valley and intermediate between those of Boise and McCall. The available data are summarized in Table 1.

The forest belts of the northern and central Rocky Mountains extend through three life zones: Transition, Canadian, and Hudsonian. The Boise Basin is almost wholly included in the Transition, but the higher ridges surrounding it extend into the Canadian zone. The vegetation in the lower Thorn Creek Valley is typical of the arid Transition.

In the northern Rocky Mountains of Montana and Idaho the principal forest trees are coniferous. The main stream border trees according to Kirkwood (20) are *Populus trichocarpa*, *Alnus tenuifolia* and *Betula fontinalis*. These three species occur along almost every stream on the western slope of the Continental Divide in the northern Rockies. *Populus tremuloides*, *Salix cordata*, *S. fluviatilis*, *Cornus stolonifera* and others may also occur. The principal forest trees are *Pinus ponderosa*, *P. contorta*, *P. albicaulis*, *Larix occidentalis*, *Pseudotsuga taxifolia*, *Picea Engelmannii*, *Abies lasiocarpa* and *Juniperus scopulorum*. Such species as *Pinus monticola*, *Tsuga heterophylla*, *Abies grandis* and *Thuja plicata* may be locally important. Plate 1 illustrates the present vegetation at Thorn Creek.

A collection was made of all woody species found between the first fork of

TABLE 1.—Weather data from southwestern Idaho localities near Thorn Creek.

Weather station	Boise	Garden Valley	Idaho City	McCall
Elevation	2,739	3,300	4,000	5,025
Life zone	Sonoran	Transition	Transition	Canadian
Average annual precipitation	13.38	21.79	21.31	25.56
Months with less than one inch precipitation	June-Sept.	June-Sept.	June-Sept.	July-Aug.
Months of maximum precipitation	Dec. Jan.	Nov. Jan.	Nov. Feb.	Dec. Jan.
Amount of maximum monthly precipitation in inches	1.67 1.90	3.49 3.42	3.04 3.07	3.64 3.59
Average annual snowfall in inches	24.5		93.7	134.8
Average temperature	51.2			39.5
Highest temperature	121			104
Lowest temperature	-28			-34
Average number of frostless days	169	107	88	76

Thorn Creek and its mouth. This collecting covered about five miles in the lower end of the valley and yielded the following species: *Acer glabrum* Torr., *Alnus tenuifolia* Nutt., *Amelanchier alnifolia* Nutt., *Artemisia cana* Pursh, *Betula fontinalis* Sarg., *Ceanothus velutinus* Dougl., *Cornus stolonifera* Michx., *Crataegus Douglasii* Lindl., *Holodiscus discolor* Maxim., *Lonicera involucrata* Banks, *Mahonia Aquifolium* Nutt., *Opulaster malvaceus* (Greene) Kuntze, *Philadelphus Lewisii* Pursh, *Pinus ponderosa* Laws., *Populus angustifolia* James, *P. tremuloides* Michx., *P. trichocarpa* T. & G., *Prunus demissa* (Nutt.) Walp., *Pseudotsuga taxifolia* (Poir.) Britt., *Purshia tridentata* (Pursh) DC., *Rhamnus Purshiana* DC., *Rhus Toxicodendron* L., *Ribes americanum* Mill., *R. cereum* Dougl., *Rosa acicularis* Lindl., *Rubus leucodermis* Dougl., *R. strigosus* Michx., *Salix exigua* Nutt., *S. Scouleriana* Barratt, *Sambucus glauca* Nutt., *Sorbus scopulina* Greene, *Spirea lucida* Dougl., and *Symphoricarpos racemosus* Michx.

Composition of the Fossil Flora

Polypodiaceae

Pteris calabazensis Dorf.

Pinaceae

Pinus quinifolia n. sp.

Pinus sp. (seed)

Picea lahontensis MacG.

Pseudotsuga Masoni MacG.

Abies laticarpa MacG.

Abies parviseminis LaMotte

Abies sp. (cone scale)

Sequoia affinis Lesq.

Sequoia Langsdorfii (Brongn.) Heer

Thuja Garmani Lesq.

Typhaceae

Typha Lesquereuxi Cockerell

Salicaceae

Populus balsamoides Goepp.

Populus Booneana n. sp.

Populus dolichopylla n. sp.

Populus eotremuloides Knowlt.

Populus washoensis Brown

Salix boisensis n. sp.

Salix Schimperii Lesq.

Salix spokanensis (Berry) Brown

Salix venosiuscula n. sp.

PLATE I

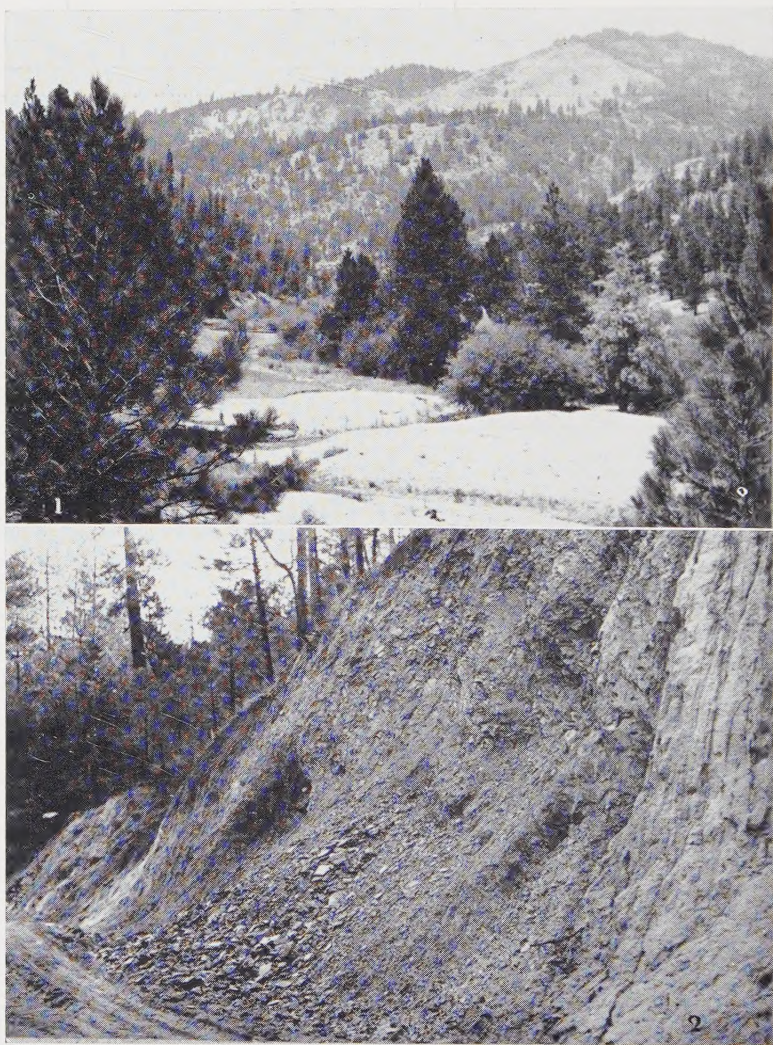


Fig. 1. A view of the lower Thorn Creek Valley showing the general topography and vegetation. The conifers on the hillsides are yellow pine and the typical deciduous association along the stream is composed of birches, alder and willows. Fig. 2. A view of the road-cut from which the fossils were obtained. The folding of the bed is evident.

- Juglandaceae
Carya egregia (Lesq.) LaMotte
Carya pecanoides (Chaney) n. comb.
 Betulaceae
Carpinus payettensis n. sp.
Betula idahoensis H. V. Smith.
Betula lacustris MacG.
Alnus carpinoides Lesq.
Alnus corallina Lesq.
Alnus sp. (cones)
 Fagaceae
Fagus pacifica Chaney
Castanopsis angustifolia n. sp.
Quercus boisiensis n. sp.
Quercus Bretzi Chaney
Quercus Browni Brooks
Quercus clarnensis Trelease
Quercus deflexiloba n. sp.
Quercus Eoprinus H. V. Smith
Quercus Maccannii Berry
Quercus Merriami Knowlt.
Quercus payettensis Knowlt.
Quercus pseudolyrata Lesq.
Quercus simulata Knowlt.
Quercus Tuckeri n. sp.
 Ulmaceae
Ulmus paucidentata H. V. Smith
 Magnoliaceae
Magnolia oregoniana Chaney
 Saxifragaceae
Ribes sp.
 Rosaceae
Amelanchier dignata (Knowlt.) Brown
Amelanchier subserrata n. sp.
Crataegus microcarpifolia Arnold
Pyrus heteromorpha n. sp.
Cercocarpus cuneatus Dorf
Prunus Chaneyi Condit
Prunus covea Chaney
 Meliaceae
Cedrela (?) *pteriformis*
 (Berry) Brown
 Aceraceae
Acer glabroides Brown
Acer negundoides MacG.
Acer Osmonti Knowlt.
Acer Scottiae MacG.
Acer sp. (samara)
Acer sp. (samara)
 Sapindaceae
Sapindus idahoensis n. sp.
 Rhamnaceae
Rhamnus idahoensis Brown
Rhamnus sp.
Ceanothus sp.
 Tiliaceae
Tilia parvulifolia n. sp.
 Ericaceae
Arbutus idahoensis (Knowlt.) Brown
Arbutus Matthesii Chaney
Arbutus opaca n. sp.
Rhododendron idahoensis H. V. Smith
 Ebenaceae
Diospyros elliptica Knowlt.
 Oleaceae
Fraxinus leptocarya n. sp.
 Caprifoliaceae
Symphoricarpos elegans (Lesq.) Smith

In order to show more clearly the numerical representation, Table 2 has been prepared. Only the well preserved impressions were retained and counted from the first year's collecting. During the collecting season of 1939 counts were made of all indentifiable specimens.

Relationships with Living Floras

The aspect of the Thorn Creek fossil flora is typically modern. The fossils have been carefully compared with living species and those to which they are most similar are taken to be the most closely related and presumably indicate the climatic conditions under which the fossils lived. Whether or not this assumption is justified cannot be discussed here further than to say that to the workers who are now most active, it appears to give the most reasonable approach to a difficult problem.

Studies of living species have been made both in the field and on herbarium specimens. In the University of Michigan Herbarium the species comprising the flora of the eastern United States and the Appalachian region are well represented. Field studies of this flora have been made in the vicinity of Ann Arbor, Mich., and in the Great Smoky Mountains of Tennessee and North Carolina. The flora of the Rocky Mountains was studied in south central

Idaho. Field work on the Pacific Coast floras was carried on in the Olympic Mountains of Washington and in northern California and southern Oregon.

TABLE 2.—List of named species and the number of specimens of each identified from the Thorn Creek flora.

Species	Number of Speci- mens	per cent	Species	Number of Speci- mens	per cent
<i>Quercus Eoprinus</i>	852	43	<i>Acer Osmonti</i>	3	
<i>Fagus pacifica</i>	348	17	<i>Arbutus Matthesii</i>	3	
<i>Quercus pseudotyrata</i>	142	7	<i>Betula idahoensis</i>	3	
<i>Salix Schimperii</i>	91	5	<i>Fraxinus leptocarya</i>	3	
<i>Acer glabroides</i>	86	4	<i>Picea lahontensis</i>	3	
Total of first five	1519	76	<i>Populus balsamoides</i>	3	
<i>Populus eotremuloides</i>	63	3.1	<i>Symphoricarpos elegans</i>	3	
<i>Ulmus paucidentata</i>	33	1.7	<i>Thuja Garmani</i>	3	
<i>Quercus Merriami</i>	31	1.6	<i>Abies laticarpus</i>	2	
<i>Quercus clarnensis</i>	27	1.3	<i>Alnus carpinoides</i>	2	
<i>Populus dolichophylla</i>	26	1.3	<i>Arbutus idahoensis</i>	2	
Total of second five	180	9	<i>Arbutus opaca</i>	2	
<i>Quercus Bretzi</i>	23		<i>Carya egregia</i>	2	
<i>Quercus payettensis</i>	22		<i>Crataegus microcarpifolia</i>	2	
<i>Rhododendron idahoensis</i>	22		<i>Prunus covea</i>	2	
<i>Quercus simulata</i>	20		<i>Pseudotsuga Masoni</i>	2	
<i>Salix venosiuscula</i>	19		<i>Quercus deflexiloba</i>	2	
Total of third five	105	5	<i>Salix boisienis</i>	2	
<i>Quercus Tucherii</i>	18		<i>Abies parviseminis</i>	1	
<i>Castanopsis angustifolia</i>	18		<i>Acer negundoides</i>	1	
<i>Quercus Brownii</i>	17		<i>Amelanchier dignata</i>	1	
<i>Sequoia affinis</i>	17		<i>Amelanchier subserrata</i>	1	
<i>Populus washoensis</i>	16		<i>Carpinus payettensis</i>	1	
Total of fourth five	86	4	<i>Carya pecanoides</i>	1	
<i>Pinus quinifolia</i>	12		<i>Cedrela pteriformis</i>	1	
<i>Sapindus idahoensis</i>	7		<i>Cercocarpus cuneatus</i>	1	
<i>Quercus boisiensis</i>	6		<i>Diospyros elliptica</i>	1	
<i>Salix spokanensis</i>	6		<i>Magnolia oregoniana</i>	1	
<i>Sequoia Langsdorffii</i>	6		<i>Prunus Chaneyi</i>	1	
<i>Alnus corrallina</i>	5		<i>Pteris calabazensis</i>	1	
<i>Populus Booneana</i>	5		<i>Quercus Maccanni</i>	1	
<i>Pyrus heteromorpha</i>	5		<i>Rhamnus idahoensis</i>	1	
<i>Acer Scottiae</i>	4		<i>Tilia parvulifolia</i>	1	
<i>Betula lacustris</i>	4		<i>Typha Lesquereuxi</i>	1	
Total, last ten	60	3	Total, this column	60	
Total, this column	1950	97	per cent total		3
Total number of species included in this count				64	
Total number of specimens included in this count				2010	

These studies indicated that the Thorn Creek fossils may be divided into groups on the basis of the geographic range of similar living types, namely: (1) those whose nearest living equivalents grow in the Rocky Mountains, and more particularly in the northern Rockies, and (2) those now represented by living allies in the eastern United States, especially the Appalachian region. Of less importance are (3) the species now represented on the humid Pacific Coast and (4) those in the arid southwest.

Some of the living species such as *Pteris* (*Pteridium*) *aquilina* and *Salix cordata* are represented in all of these areas, and are, therefore, not important as indicators of floristic affiliations or of climatic conditions.

The absence of an eastern Asiatic element so common in many of the western Tertiary floras is of interest. Many of the genera which have become extinct in the West are found in eastern Asia as well as eastern United States, but in practically all cases I believe that the Thorn Creek fossils are more similar to the American species.

On the basis of the number of species, the northern Rocky Mountain and Appalachian elements are about equally important. The Rocky Mountain element includes woody species that occur in the north or at high elevations farther south. Many of these species correspond to those that comprise the major forest cover of the mountains, while others grow along the streams or in moist valleys.

The Rocky Mountain element is of particular interest and is here treated in two parts: first, those species whose living equivalents were collected at Thorn Creek, and second, those for which the living equivalents occur elsewhere in the region.

Of the twenty-eight living woody genera now present at Thorn Creek fourteen are represented in the fossil flora. All except *Pseudotsuga* are far ranging in North America. The genera which are represented by both living and fossil species at Thorn Creek are: *Acer*, *Alnus*, *Amelanchier*, *Betula*, *Ceanothus*, *Crataegus*, *Pinus*, *Populus*, *Prunus*, *Pseudotsuga*, *Rhamnus*, *Ribes*, *Salix* and *Symphoricarpos*.

A more detailed picture of the similarity between the floras is given by a parallel listing of the related living and fossil species found at Thorn Creek:

Fossil species	Similar living species
<i>Acer glabroides</i>	<i>A. glabrum</i>
<i>Amelanchier dignata</i>	<i>A. alnifolia</i>
<i>Betula lacustris</i>	<i>B. fontinalis</i>
<i>Populus Booneana</i>	<i>P. tremuloides</i>
<i>Populus dolichophylla</i>	<i>P. angustifolia</i>
<i>Populus eotremuloides</i>	<i>P. trichocarpa</i>
<i>Pseudotsuga Masoni</i>	<i>P. taxifolia</i>
<i>Pteris calabazensis</i>	<i>P. aquilina</i>
<i>Rhamnus idahoensis</i>	<i>R. Purshiana</i>
<i>Salix boisiensis</i>	<i>S. Scouleriana</i>
<i>Symphoricarpos elegans</i>	<i>S. racemosus</i>

Populus tremuloides, *Pteris aquilina* and *Symphoricarpos racemosus* range over a very wide area. The remaining species are exclusively western and are mostly typical Rocky Mountain plants.

A number of fossils appear to be closely related to present day northern Rocky Mountain plants not found near the fossil bed. Some of these living species grow in low areas of the panhandle region of Idaho or in higher elevations throughout the Rockies. Many occur generally in southwestern Idaho.

Fossil species
Alnus corrollina
Alnus carpinoides
Cercocarpus cuneatus
Picea lahontensis
Pinus quinifolia
Prunus covea
Salix spokanensis
Salix Schimperii
Thuja Garmani

Similar living species
A. rhombifolia Nutt.
A. sinuata (Regel) Rydb.
C. montanus Raf.
P. Engelmannii (Parry) Engelm.
P. monticola Dougl.
P. emarginata (Dougl.) Walp.
S. commutata Bebb
S. cordata Muhl.
T. plicata D. Don

This very marked similarity between twenty species of the fossil and living floras of Thorn Creek and vicinity indicates that a flora closely similar in certain respects to the modern Rocky Mountain flora was present in that region as early as Tertiary times. In addition, it contained elements indicating a climate distinctly more humid. It would appear that the commonest fossil species were of eastern affinity and have become extinct in the West without leaving descendents, whereas the already differentiated western element of the fossil flora consisted principally of species that have left living descendents in the same general region.

The largest percentage of actual specimens fall in the group of species with supposed living equivalents in the northeastern states and in the Appalachian region. Since the preliminary account (34) of Thorn Creek fossils with supposed living equivalents in the eastern United States was written, several additional species have been added to that category. The range of some of these plants extends into the southeastern Atlantic states. The revised list follows:

Fossil species
Acer negundooides
Acer Osmonti
Betula idahoensis
Carpinus payettensis
Carya egregia
Fagus pacifica
Fraxinus leptocarya
Magnolia oregoniana
Populus Booneana
Populus washoensis
Prunus Chaneyi
Pteris calabazensis
Quercus Bretzi
Quercus Eoprinus
Quercus Maccanni
Quercus Merriami
Quercus payettensis
Rhododendron idahoensis
Salix Schimperii
Symphoricarpos elegans
Tilia parvulifolia
Ulmus paucidentata

Similar living species
**A. Negundo* L.
A. saccharinum L.
B. lenta L.
C. carolinana Walt.
C. ovata K. Koch
F. grandifolia Ehrh.
F. quadrangulata Michx.?
M. virginiana L.
**P. tremuloides* Michx.
P. grandidentata Michx.
P. serotina Ehrh.
**P. aquilina* L.
Q. bicolor Willd.
Q. Prinus L. (*Q. montana* Michx.)
Q. bicolor Willd.
Q. rubra L.
Q. Muhlenbergii Engelm.
R. maximum L.
**S. cordata* Muhl.
**S. racemosus* Michx.
T. floridana Small
U. alata Michx.

The species marked with an asterisk are of wide distribution and are not necessarily characteristic of the flora of the eastern United States. *Betula*, *Populus*, *Prunus*, *Rhododendron* and *Fraxinus* occur in both eastern and western United States. The first three are found in southwestern Idaho, mostly as stream border plants. Thus, *Carpinus*, *Carya*, *Fagus*, *Magnolia*, five species of *Quercus*, *Tilia* and *Ulmus* are the really characteristic eastern American representatives. It is curious that whereas *Fagus pacifica* and *Quercus Eoportunus* are the numerical dominants in the flora and the *Ulmus* is well represented, the other nine species are now known from only a few specimens. This may be because the collections all came from a single locality. Collections from a neighboring fossil bed, if one could be found, might have a somewhat different numerical distribution. *Fagus* of the *F. grandifolia* type grew over a considerable part of the northwest during the Miocene, but neither its principal ecological associate at Thorn Creek, *Quercus Eoportunus*, nor a closely similar species has been reported associated with it elsewhere. Several common members of the eastern hardwood association are not included in this flora. *Castanea*, *Nyssa*, *Liriodendron*, *Liquidamber* and *Sassafras* have not been reported from various nearby Miocene floras, but so far as is now known, they are absent from Thorn Creek.

A number of the fossil species have living representatives now growing in the humid Pacific Coast regions.

Fossil species

Acer glabroides
Acer negundoides
Alnus corrallina
Alnus carpinoides
Amelanchier dignata
Arbutus Matthesii
Castanopsis angustifolia
Populus Booneana
Populus eotremuloides
Prunus covea
Pseudotsuga Masoni
Pteris calabazensis
Quercus Browni
Quercus pseudolyrata
Rhamnus idahoensis
Salix Schimperii
Salix boisiensis
Salix venosiuscula
Sequoia Langsdorffii
Symphoricarpos elegans
Thuja Garmani

Similar living species

**A. glabrum* Torr.
 **A. Negundo* L. and varieties
 **A. rhombifolia* Nutt.
 **A. sinuata* (Regel) Rydb.
 **A. alnifolia* Nutt.
A. Menziesii Pursh
 **C. chrysophylla* DC.
 **P. tremuloides* Michx.
 **P. trichocarpa* T. & G.
 **P. emarginata* Walp.
 **P. taxifolia* (Poir.) Britt.
 **P. aquilina* L.
Q. chrysolepis Liebm.
Q. Kelloggi Newb.
 **R. Purshiana* DC.
 **S. cordata* Muhl.
 **S. Scouleriana* Barr.
 **S. lasiandra* Benth.
S. sempervirens Endl.
 **S. racemosus* Michx.
 **T. plicata* D. Don

As in the previous list the asterisk means that the living species is not confined to the area mentioned. It is clear from the above list that no really typical redwood or redwood border element (association) was important at Thorn Creek at the time of the deposition of these sediments. Of the species confined to the coastal region one, *Q. Kelloggi*, may not necessarily be the most similar living equivalent for the fossil form. There are two or three eastern American black oaks that also closely resemble *Q. pseudolyrata*. *Sequoia* of

the coast redwood type is represented by only a few specimens. *Arbutus Matthesii* is likewise sparsely represented. *Q. Browni*, having as its living equivalent *Q. chrysolepis*, is suggestive of some of the Coast Range associations. The almost total absence of the ecological associates of redwood is in contrast with many of the earlier Miocene floras and serves to place the probable age of the Thorn Creek flora in the middle or late Miocene.

The southwestern element is small and includes mostly semi-chaparral species and a few that are widespread or occur in some of the other regions mentioned.

Fossil species
Acer negundoides
Arbutus opaca
Cercocarpus cuneatus
Diospyros elliptica
Populus Booneana
Pseudotsuga Masoni
Pteris calabazensis
Quercus boisiensis
Quercus simulata
Quercus Tuckeri
Sapindus idahoensis

Similar living species
 **A. Negundo* L.
A. glandulosa M. & G.
 **C. montanus* Raf.
D. Texana Scheele
 **P. tremuloides* Michx.
 **P. taxifolia* (Poir.) Britt.
 **P. aquilina* L.
Q. Eastwoodiae Rydb.
Q. hypoleuca Engelm.?
Q. annulata Sarg.
S. Drummondii Hook. & Arn.

Almost half of these living species are found in other regions. The box elder, quaking aspen and bracken are widely distributed. *Cercocarpus* and *Pseudotsuga* are common in the western flora. The latter reaches the southern limit of its distribution in the mountains of northern Mexico. None of these can be considered as characteristic of any one region or any particular set of climatic conditions except that they grow in the drier parts of the various mesophytic regions.

The remaining species definitely suggest a scrubby forest dominated by oak and madrone. This type of association is encountered in some of the inner Coast Ranges of northern California as well as in the mountains of Mexico. A vegetation without the madrone, but of probably similar aspect, is found in the Wasatch Mountains east of Salt Lake City, Utah. *Sapindus*, *Diospyros* and *Cercocarpus*, growing as they do as scattered trees, scrubby trees or shrubs in fairly dry subchaparral habitats, are not unlikely additions to such an association. It seems reasonably safe to assume that such an association, with the possible addition of *Quercus clarnensis*, occupied the drier ridges and south-facing slopes around the bed of deposition.

The affinity between certain western Miocene oaks and those from the southwest and northern Mexico has been previously pointed out by Berry (5). Although growing in an arid region, these living equivalents usually grow in canyons or near streams where there is at least a moderate supply of water. According to a written note (unpublished) by Professor H. H. Bartlett:

Collectors in arid portions of Mexico frequently have the experience of turning up species of highly restricted and localized distribution as relicts of an old mesophytic vegetation in deep ravines, near mountain streams and along hills. As an example one may cite a typical hickory and an elm related to the group of *Ulmus americana* which maintain a most precarious existence in isolated bits of mesophytic habitat in the moun-

tains of Tamaulipas and Nuevo Leon. This hickory, particularly, could in no way span the desert stretches that lie between the isolated and small areas where it grows. Here we have an example of the dying out, not yet complete, of species in arid Mexico which may in former geological times have extended much farther to the westward.

Ecological Considerations

On the basis of the habitats of the supposed living equivalents an area of considerable altitudinal range is indicated by the fossil plant assemblage. Certain of the supposedly equivalent living species are characteristic of high altitudes and grow usually above 5000 feet either in the Rocky Mountains or Sierra Nevadas or both. Other species are restricted to wet or swampy places in lower elevations. A third group intermediate between these two is recognized and includes species of uplands and fairly dry ridges.

Certain plants, such as *Pseudotsuga* and *Pteris*, are found from sea level up to great elevations. Because of its scarcity in this fossil record the former is here considered to have been growing in the higher mountains and was consequently at some distance from the place of deposition. The *Pteris* appears to be more similar to those specimens which grow under somewhat xerophytic conditions than to the specimens which grow in the humid coastal regions. The following list enumerates those species in the fossil flora that may have been characteristic of high elevations.

<i>Abies laticarpa</i>	<i>Pinus quinifolia</i>
<i>Abies parviseminis</i>	<i>Populus Booneana</i>
<i>Acer glabroides</i>	<i>Populus dolichophylla</i>
<i>Alnus carpinoides</i>	<i>Populus eotremuloides</i>
<i>Alnus corrallina</i>	<i>Pseudotsuga Masoni</i>
<i>Amelanchier dignata</i>	<i>Salix Schimperii</i>
<i>Amelanchier subserata</i>	<i>Salix spokanensis</i>
<i>Betula lacustris</i>	<i>Salix venosiuscula</i>
<i>Picea lahontensis</i>	<i>Sequoia affinis</i>

All of the above species except *P. eotremuloides* are meagerly represented as is quite in keeping with their postulated growth at high altitudes. The leaves of *P. eotremuloides* appear to be moderate in size and fairly thick. They are suggestive of leaves of the living *P. trichocarpa* as it is found at Thorn Creek. Leaves of this species from humid coastal areas are larger and thinner. The other species of *Populus* and *Alnus* are not necessarily restricted to high altitudes, but since they are surprisingly poorly represented, it is probable that they were growing either at higher elevations some distance from the place of deposition or as scattered individuals. This sparse representation is in decided contrast to certain species from some of the other groups.

The largest number of species belong to the group that apparently grew at intermediate elevations. Two elements can be recognized, the semi-chaparral and the mesophytic hardwood species. The following list enumerates the supposed xero-mesophytic semi-chaparral species.

<i>Arbutus opaca</i>	<i>Quercus simulata</i>
<i>Cercocarpus cuneatus</i>	<i>Quercus Tuckeri</i>
<i>Diospyros elliptica</i>	<i>Sapindus idahoensis</i>
<i>Quercus boisiensis</i>	<i>Ulmus paucidentata</i>

The second list includes mesophytic hardwood species which seem more associable with the flora of eastern America than with the semi-chaparral element. These species of eastern aspect probably occupied the more mesophytic parts of areas that were becoming, even in the Miocene, semi-arid and in which the immigration of chaparral species had begun. The latter may be presumed to have gained ascendancy as the eastern element dwindled and eventually became extinct. The evidence that there was a beech-maple association would indicate ecological conditions not unlike those that characterize the region of beech-maple climax forest in the eastern states. We may tentatively conclude that this beech-maple climax was being succeeded by a new semi-chaparral climax as a result of increasing dryness. In other words, beech-maple forest at the time of deposition of the beds ceased to be the wide-spread climatic climax of the region and was on the wane. It probably existed only in favored localities, such as in a locality in the eastern Sierra Madre of Mexico where S. S. White* has found a typically Alleghanian-Ozarkian flora which persists as a relic in a wet canyon surrounded by a region of subdesert vegetation. H. H. Bartlett* found a similar localized florula in the San Carlos Mountains of Tamaulipas. The mesophytic species follow:

<i>Acer negundooides</i>	<i>Quercus Eoprinus</i>
<i>Betula idahoensis</i>	<i>Quercus Merriami</i>
<i>Carya egregia</i>	<i>Quercus payettensis</i>
<i>Castanopsis angustifolia</i>	<i>Quercus pseudolyrata</i>
<i>Fagus pacifica</i>	<i>Rhamnus idahoensis</i>
<i>Fraxinus leptocarya</i>	<i>Sequoia Langsdorfii</i>
<i>Pteris calabazensis</i>	

A few species may have been typically lowland and two or three others may be considered either intermediate or lowland.

<i>Carpinus payettensis</i>	<i>Rhododendron idahoensis</i>
<i>Castanopsis angustifolia</i>	<i>Tilia parvulifolia</i>
<i>Magnolia oregoniana</i>	<i>Thuja Garmani</i>
<i>Quercus Bretzi</i>	

The living equivalents of this group grow on moist bottom lands, along streams or in low swampy places and usually are not found at higher elevations. *Carpinus*, *Magnolia* and swamp chestnut oaks no longer occur in the West. None of this group is well represented in the fossil flora.

It is evident from the geographic distribution of the living equivalents that the Thorn Creek flora grew in an area of considerable topographic relief. The topography may have been much the same as it is in the Boise Basin today, that is, fairly broad valleys surrounded by high mountains. The majority of the plants represented as impressions grew in the basin or low valleys, others were found on the low hills and the conifers grew on the high mountains. The precipitation was probably not less than thirty inches annually, and there was no pronounced summer dry season such as now prevails in that region. The temperature, except on the high mountains, was probably not extreme and not subject to great variation.

* Oral communication of H. H. Bartlett, April, 1940.

Comparison with Other Fossil Floras

Table 3 shows the distribution of the species of fossil plants found at Thorn Creek in certain other western fossil beds. However, the value of such a chart is somewhat limited. Because of the different methods of interpreting fossil species followed by various paleobotanists, such a table does not give an adequate picture of the ecological similarities between two floras. Perhaps more important, it does not emphasize all of the significant differences. For these reasons a brief discussion of the associations and numerical dominants where reported, may prove to be at least as significant, if not more so, than a mere numerical comparison of the number of similar species reported from various floras.

In Lindgren's original collection of Payette plants thirty-two species were enumerated. Because of the doubtful determinations and inadequate illustrations, systematic and consequently ecological relationships between the original Payette flora and that of Thorn Creek are hard to determine. It is hardly likely that the generic determinations of *Ficus*, *Celastrus*, *Rhus* and *Myrica* are correct. Three of the Thorn Creek species, *Populus oetremuloides*, *Quercus simulata* and *Q. payettensis*, were included in the original collection of Payette plants. It is highly probable that *Sequoia angustifolia*?, *Myrica*? *idahoensis*, *Populus occidentalis*, *Platanus aspera*?, *Celastrus Lindgreni* and *Acer trilobatum productum*? are the same as *Sequoia Langsdorfii*, *Arbutus idahoensis*, *Populus oetremuloides*, *Acer glabroides*, *Populus dolichophylla* and *Acer glabroides* respectively of the Thorn Creek flora. It is likely that a study of the actual collections would show a greater number of identities.

The Sucker Creek flora is not as homogenous as is that from Thorn Creek. Neither is it so clearly related to any one modern flora. *Quercus* is the dominant genus in both with seven species reported from the former and twelve from the latter. There is a distinct difference in the type of oaks represented. The Sucker Creek beds have almost exclusively narrow, rather coriaceous-leaved species, whereas Thorn Creek in general has broad, apparently thin-leaved species. Moreover, two species of *Castanea* and *Castanopsis* have been reported from Sucker Creek, the latter being very abundant. *Castanea* is apparently not present at Thorn Creek whereas *Castanopsis* is represented by a new species. *Fagus* at Sucker Creek is rather rare, as are willows. *Platanus* is very abundant and three species have been reported. Four species of fossil *Mahonia* are known from Sucker Creek, but no fossil record of the genus has yet been found at Thorn Creek where a living species is growing just above the fossil bed. *Pinus* is found in both floras, but is represented by totally different types. At Sucker Creek the three-needled *P. Knowltoni* (presumably related to the modern yellow pines) is common in certain localities, whereas the Thorn Creek *Pinus* is a five-needled one (i. e., a white pine). Only two fern fragments have been found at Thorn Creek. There is a whole ledge of *Woodwardia deflexipinna* at Sucker Creek near Rockville, Oregon. Fern fragments have not been observed from the other Sucker Creek localities, however.

Of the fifty-eight Sucker Creek species which I (35) have recognized, eighteen have living equivalents in the western United States, only a few of

TABLE 3.—Distribution of Thorn Creek species in some other western Tertiary floras.

	Lower										Middle or Upper Miocene			Transitional or Pliocene		
	Miocene															
	*	1	2	3	4	5	6	7	8	9	10	11	12	13		
<i>Abies laticarpa</i>						x	x	x								
<i>Abies parviseminis</i>								x								
<i>Acer glabroides</i>		x		x			x	x		x	x	x				
<i>Acer negundoides</i>				x	x	x		x			x	x				
<i>Acer Osmonti</i>					x					?	x					
<i>Acer Scottiae</i>						x						x				
<i>Alnus carpinoides</i>		x		x		x	x	x			x					
<i>Alnus corrallina</i>				x					x			x				
<i>Amelanchier dignata</i>					x	x						x				
<i>Arbutus idahoensis</i>				x		x	x			x	x	x				
<i>Arbutus Matthesii</i>		x						x								
<i>Betula lacustris</i>						x										
<i>Carya egregia</i>				x			x	x			x					
<i>Cedrela pteriformis</i>				x												
<i>Cercocarpus cuneatus</i>														x		
<i>Craetagus microcarpifolia</i>						x										
<i>Diospyros elliptica</i>					x											
<i>Fagus pacifica</i>		x	?	x			x	x			x					
<i>Magnolia oregoniana</i>			x													
<i>Picea lahontensis</i>						x						x				
<i>Populus eotremuloides</i>				x				x		x	x					
<i>Populus washoensis</i>								x			x					
<i>Prunus Chaneyi</i>									x							
<i>Prunus covea</i>		x					x				x					
<i>Pseudotsuga Masoni</i>						x		?				x				
<i>Pteris calabazensis</i>														x		
<i>Quercus Bretzi</i>			x	x												
<i>Quercus clarnensis</i>		x														
<i>Quercus Maccannii</i>				x								x				
<i>Quercus Merriami</i>			x	x	x											
<i>Quercus payetensis</i>				x						x						
<i>Quercus pseudolyrata</i>			x		x		x	x								
<i>Quercus simulata</i>			x	x		x	x	x		x	x	x	x			
<i>Rhamnus idahoensis</i>				x												
<i>Salix spokanensis</i>				x												
<i>Sequoia affinis</i>														x		
<i>Sequoia Langsdorfii</i>		x		x	x			x		x	x	x	x			
<i>Symphoricarpos elegans</i>											x	x				
<i>Thuja Garmani</i>												x	x			
		7	5	17	7	11	9	13	2	6	13	13	3	2		

* See page 487 for explanation.

which are associates of the modern redwood. In both floras *Sequoia* is rare. Nineteen Sucker Creek species have closely related living equivalents in the eastern United States. Several of these are in the genera *Ulmus*, *Sassafras*, *Ostrya*, *Nyssa*, *Fagus* and *Carya* now extinct in the West. In contrast to the Thorn Creek flora that of Sucker Creek has an eastern Asiatic element of some importance, comprising ten species and including three genera that do not occur naturally in the United States.

From a comparison of these two neighboring fossil florulas (both of which are probably Payette) it seems evident that, on the basis of present knowledge, the Sucker Creek florula is more cosmopolitan. It must, however, be borne in mind that this florula has been collected from numerous localities, some of which are separated by twenty-five or thirty miles, whereas the Thorn Creek specimens were all taken from a single outcrop.

Other nearby fossil beds are the Idaho beds near Weiser, Idaho. Dorf (16) has pointed out the similarity of this flora to that of the *Lithocarpus-Quercus-Arbutus* community of the inner Coast Ranges of California. The most important species numerically were listed as *Typha Lesquereuxi*, *Quercus simulata*, *Acer negundooides*, *Salix coalingensis* and *Juniperus sabinoides*. None of these is dominant at Thorn Creek and several do not even occur there so far as is now known. Six species of *Quercus* were reported, but the broad-leaved black oaks and the chestnut oaks so common at Thorn Creek are either scarce or lacking.

The two floras have several points of similarity not brought out in the table. Both, for instance, have *Fraxinus* samaras, small *Ulmus* leaves, *Ulmus* fruits, *Abies* fragments, *Cercocarpus* leaves and *Pinus* needles, which although now considered specifically distinct may not all be so. Only a few Weiser species have living equivalents in eastern Asia, and only a few have living representatives confined to the eastern United States.

The Blue Mountain flora as published by Oliver (29) on collections from Tipton and Austin, Oregon, comprises thirty-two species. Of the seven conifers, *Sequoia Langsdorfii* and *Pinus Knowltoni* are abundant. Three elements were observed, (1), the Pacific Coast element of twenty species which included both redwood and non-redwood associates; (2), Appalachian element of seven species; and (3) the eastern Asiatic element. In contrast to the Thorn Creek flora, the small non-lobed oaks are abundant and only *Q. pseudolyrata* represents the broad leaved species. *Platanus* and a large-leaved *Acer* are found in the Blue Mountain flora. It is evident that these two floras could not have been very similar in aspect even though they have eleven species in common.

The Trout Creek flora of south central Oregon, like that of Thorn Creek,

* 1, Bridge Creek; 2, Eagle Creek; 3, Latah of Wash. and n. Idaho; 4, Mascall, John Day Basin; 5, Trout Creek; 6, Blue Mountains; 7, Upper Cedarville; 8, San Pablo; 9, Type Payette; 10, Sucker Creek; 11, Weiser; 12, Linson Valley, Idaho; 13, Pliocene, California.

resembles a modern flora of the western mountains. However, the vegetation of the Klamath Mountains, which the former resembles, differs in many respects from that of the northern and central Rockies. According to MacGinitie (28) the numerical dominants of the fossil flora are tan oak, madrone, Douglas fir and Port Orford Cedar equivalents. There is also a considerable Asiatic element. From this it is evident that the two fossil floras are quite dissimilar.

Fourteen Thorn Creek species have been reported from the Latah formation of Washington and northern Idaho. If a careful comparison of nearly similar species were made this resemblance would undoubtedly be increased. It is probable that *Pinus tetrafolia* is the same as *P. quinifolia*, that *Pteris* sp. is a form of *P. aquilina* and the same as *P. calabazensis* from Thorn Creek, etc. With the large representation of *Fagaceae*, *Salicaceae* and *Betulaceae*, the Latah flora must have had a facies somewhat like that of Thorn Creek. The former flora contains over one hundred and fifty species and is the largest of those considered here.

According to Berry (5) the most numerous leaves are those of oaks, poplars, redwood and bald cypress. In discussing the flora he wrote, "The Latah flora is an overwhelmingly temperate flora entirely appropriate to the latitude where it is found, and indicative of an ample, well distributed rainfall of possibly between 30 and 40 inches annually. It is rather closely paralleled among existing floras by those of such a Middle Atlantic State as Maryland." This flora must have lived under moister conditions than the Sucker Creek and Thorn Creek floras since *Sequoia* and *Taxodium* are abundant in it.

The Upper Cedarville flora of northwestern Nevada and adjacent California as presented by LaMotte (24) consists of forty-six species. *Typha Lesquereuxi*, *Sapindus oregonianus* and *Carya egregia* constitute 55 percent of the total number of impressions. None of these is numerically important at Thorn Creek although *Fagus pacifica* which is sixth in the Upper Cedarville is second in the Thorn Creek collection and *Quercus simulata* and *Carya egregia* are present in small numbers. LaMotte found that over 65 per cent of the nearest living equivalents are to be found in the present flora of the west coast. Second in importance are those species with living equivalents in eastern Asia. A smaller number are represented in the eastern United States.

The main climax association is supposed to have been an oak-hickory-beech association suggestive of the hardwood forests of eastern Asia and eastern America. The flora as a whole indicates a cool climate with no summer dry season and considerable precipitation. The climax association is quite similar to that of Thorn Creek in the importance of oak, maple and beech.

There is scarcely any similarity between the Thorn Creek and San Pablo floras as they are now known. The latter, which is considered to be Upper Miocene, is found in California around San Francisco Bay. Condit (15) reported it as a small flora of twenty-six species. The dominant element is the *Taxodium-Nyssa* association which now occurs in the deep swamps of the southeastern coastal plain.

The lack of similarity between these fossil floras is to be expected because of the great distance separating them and because of the probably great difference in climatic conditions. There may also be some age difference, but it is not necessary to assume that this is true, since exactly the same floristic differences could easily be found today between southeastern localities not too distant, one in the Appalachian Mountains and one in the coastal plain, or one in the Ozark uplift and one in the lower Mississippi Valley.

In many respects the Eagle Creek flora is similar to that of Thorn Creek. They both have a wealth of broad-leaved oaks, and include *Fagus*, small-leaved elms, poplars of the *P. tremuloides* type, *Alnus*, *Betula*, *Carya*, *Crataegus*, *Tilia*, *Prunus*, etc. A more detailed comparison of the specimens and species than it is feasible for me to make might well show a much greater degree of similarity than is now indicated by the five species in common. As suggested by Chaney (12) and indicated in his chart showing the distribution of the modern equivalents of the Eagle Creek plants, they occupy the eastern United States where they are important members of the mesophytic hardwood forests. One point of dissimilarity is of special interest, namely, the absence of the modern Rocky Mountain element in the Eagle Creek and its presence in the Thorn Creek flora. This may be ascribed to the geographic positions of the two floras or to the fact that during Eagle Creek time the northern Rocky Mountain element was still farther to the north. This element, although present in some other fossil floras, has received little emphasis and may be of greater importance than is now generally recognized.

The Eagle Creek flora is like that of Thorn Creek in that only a few species have living equivalents confined to eastern Asia. It is also interesting to note the absence of *Platanus* at Eagle Creek, Trout Creek, the Upper Cedarville formation and Thorn Creek. Just what importance can be attached to its absence I am not prepared to say, but it is interesting because of the marked abundance of the genus in so many western Miocene floras.

The lower Miocene Bridge Creek flora of the Crooked River Basin of Oregon has been studied by Chaney (14). He found it to be like the modern redwood forest with 48 per cent of the species being redwood associates. The non-redwood western element and the eastern American element are of about equal importance, the first including 16 and the second 18 per cent of the species. The Asiatic element and those species of uncertain affinities are of minor importance. The four numerical dominants are reported as *Quercus clarnensis*, *Alnus carpinoides*, *Typha Lesquereuxi* and *Sequoia Langsdorfii*. Of these, the last three are represented by only a few specimens each at Thorn Creek. *Q. clarnensis*, however, is quite well represented.

Chaney made only generic comparisons between the fossil and living floras of Bridge Creek and vicinity. He found that twenty of the thirty-nine genera present in the fossil flora are still living in the general region of the Crooked River Basin and Blue Mountains, Oregon. It is evident that the Bridge Creek and Thorn Creek floras were quite dissimilar although there are several likenesses not brought out in the table. The small *Ulmus Brownelli* is quite similar

to *U. paucidentata*. *Crataegus Newberryi* and *C. microcarpifolia* are known only from isolated leaf impressions and may well represent a single species.

It seems likely that the Bridge Creek beds preserve a record of a habitat in which the mesophytic climatic climax had not yet been attained since *Sequoia* was dominant and *Fagus* rare. In contrast to this at Thorn Creek the climax vegetation of eastern type had been obtained and as a result of increasing aridity, was disappearing. In its place the Rocky Mountain element of the present day was coming in. This succession is quite in keeping with the supposed age relations of the two floras, the Bridge Creek is older and should, therefore, represent an earlier phase of ecological succession than the Thorn Creek flora.

From the foregoing discussion it is evident that as far as the interpretation of the ecology of the various floras is concerned, the general aspect of the Thorn Creek is in many ways distinct from them all, but that its general facies is more like the Latah flora of northern Idaho and Washington, the Upper Cedarville of Nevada and California and the Eagle Creek of the Columbia River Gorge, Oregon, than any others.

Age of the Flora

The stratigraphic occurrence of the plant bed in an intermontane basin in southwestern Idaho and its proximity to the type localities of the Pavette formation suggest that this is another outcrop of that formation and would, therefore, now be considered Upper Miocene in age. The distribution of the species in other formations of supposed Upper Miocene age also bears out this assignment.

Systematic Descriptions of Species

Species for which no comments are needed are omitted from this list. The complete list of species has been given on page 475. The fossil flora as reported in this paper includes sixty-four named species and eight that are not given specific names. These are distributed among thirty-six genera in twenty families. Only one fern is included. Six genera of the Spermatophyta are gymnosperms. Two monocotyledons have been recognized, one of which is too fragmentary for identification. A representative collection of the fossils has been deposited in the Museum of the University of Notre Dame. Type specimens only are in the Museum of Paleontology of the University of Michigan.

Pinaceae

Pinus quinifolia n. sp. Plate 2, figs. 2, 8. Needles slender, in clusters of five; sheath either absent or very inconspicuous; length of needles quite constant, about 4.5-5 cm. Type no. 21456 U. M.

A somewhat similar fascicle containing only four needles was described as *P. tetrafolia* by Berry (5). This name was based upon a single specimen and has subsequently been applied to a fossil from Weiser, Idaho. Because the typical needle number (five) shows that the Thorn Creek specimens belong to the white pines, they are described here as new although it is probable that the Latah specimens also represent a five-needled or white pine in which the fifth needle either does not show or was lost before fossilisation. In any event, it seems best to describe species on the basis of really adequate material whenever it is possible to do so.

PLATE 2

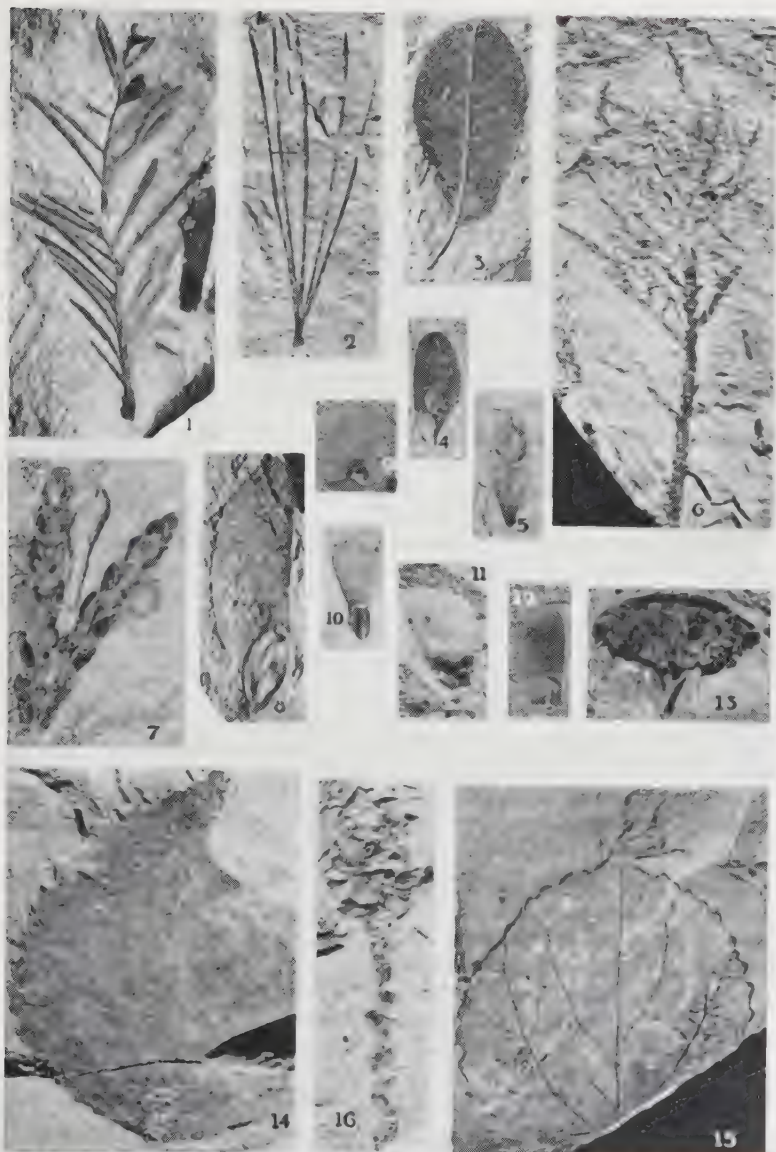


Fig. 1. *Sequoia Langsdorffii* (Brongn.) Heer. Figs. 2, 8. *Pinus quinifolia* n. sp. Fig. 2 type, no. 21456 U. M. Fig. 3. *Salix boisiensis* n. sp. Type no. 21466 U. M. Figs. 4, 5. *Pseudotsuga Masoni* MacG. Fig. 6. *Sequoia affinis* Lesq. Fig. 7. *Thuja Garmani* Lesq. $\times 2\frac{1}{2}$. Fig. 9. *Abies parviseminis* LaMotte. Fig. 10. Unidentified seed. Fig. 11. *Abies laticarpa* MacG. Fig. 12. *Pinus* sp. seed. Fig. 13. *Abies* sp. cone scale. Figs. 14, 15. *Populus Booneana* n. sp. Fig. 15 type, no. 21462 U. M. Fig. 16. Unidentified cone.

Several species of white pine have been reported from the western Miocene. *Pinus* sp. Knowlton from near Ashland, Oregon, has needles that are both longer and stouter than *P. quinifolia*. *P. latahensis* Berry from the Latah formation of Republic, Washington, is even larger, having needles at least 9 cm. long. Brown (10) has reported a five-needled pine with needles 3-4 cm. long from Thunder Mountain, Idaho. It is probable that this is the same species as the Thorn Creek material. *P. Wheeleri* Cockerell from Florissant, *P. Torreyana* Parry (a living 5-needled yellow pine supposed to be associated with *Sequoia Langsdorfii* and *Alnus carpinoides* at Bridge Creek (Mason, 27)) and *P. monticolensis* Berry from the Latah are all 5-needled pines with longer and usually considerably stouter needles than the Thorn Creek fossils.

Among living species, *P. monticola* Dougl. and *P. Strobus* L. have leaves that are quite similar to the fossils but they may be much longer also. *P. alba-aulis* Engelm. and *P. aristata* Engelm. have shorter needles which are stouter and tend to be more curved. *P. flexilis* James is almost identical in needle size but apparently the needles are more rigid. *P. monticola* is probably the nearest living equivalent of this fossil species in spite of the great variation in length of the needles. They may vary up to three or four times the observed length of the Thorn Creek fossils. This western white pine grows in the higher mountains from British Columbia to the Sierra Nevadas and extends eastward into Idaho and Montana. Its altitudinal range is great for it occurs from sea level up to 10,000 feet.

Pinus sp. seed. Plate 2, fig. 12. Seed with wing a little over 1.3 cm., seed round, 4 mm. in diameter; wing broadly strap shaped, flaring slightly for two-thirds of its length, inner margin straight to just below the apex where it curves concavely; outer margin slightly convex, then narrowed abruptly in the apical third; width of wing at point of attachment to seed 5.5 mm., at widest point 6 mm., length 1.3 cm.

In size and shape these seeds rather closely resemble *P. aristata* Engelm., the foxtail pine, which grows on rocky and gravelly slopes at the upper limit of tree growth in the Rocky Mountains.

Pseudotsuga Masoni MacG. Plate 2, figs. 4, 5. A bract and a few winged seeds are the representatives of this species. Bract 1.75 cm. long, two lateral lobes at the apex; midrib strong, extending out to form a rigid needle-like point; bract slightly constricted above the middle.

The only discernable difference between this bract and those of the living *P. taxifolia* is in the slightly smaller size of the fossil. The Douglas fir is found throughout the Rocky Mountains of the United States and occurs over a wide altitudinal range.

Abies laticarpa MacG. Plate 2, fig. 11. A single elongate seed about 2 mm. wide and 4 mm. long with an expanded wing may be referred to this species. It differs from the Trout Creek specimen illustrated by MacGinitie (28) in having a narrower wing.

Abies magnifica var. *shastensis* Lemm., a living species reported from the John Day beds by Mason (27), is also somewhat similar but the wing is shorter.

Several living species, *Abies grandis* Murr., *A. concolor* (Gord.) Parry and *A. grandis* Lindl., have seeds quite similar to the fossils.

Abies parviseminis LaMotte. Plate 2, fig. 9. A single small, almost quadrangular seed with a deltoid wing is the only representative of this species. Among living plants the seeds of *A. lasiocarpa* (Hook.) Nutt. are quite similar. This balsam fir is found from Alaska through the mountains to Oregon and in the Rockies south to Arizona.

Abies sp. (cone scale). Plate 2, fig. 13. Several cone scales suggestive of those of *Abies* are included in the collection. They are not at present assigned to either of the seed species although they probably represent at least one of them. The scales are quite like those of *A. concolor* so should, perhaps, be referred to *A. laticarpa*.

Sequoia affinis Lesq. Plate 2, fig. 6. (New classification *Sequoiadendron affinis*). Several specimens of these slender, much branched twigs clearly indicate the places for abscission of the small deciduous lateral branches. The big tree, *Sequoia gigantea* Decne., has branches of exactly the same kind. This living species, like the redwood has a very restricted range, in fact, its range is even more restricted. It is known from about thirty-two groves scattered along the western slope of the Sierra Nevadas. The temperature range endured is quite wide, from -12° to 100° F. It is evident that the big tree exists under considerably harsher conditions than does the redwood, and its occurrence at Thorn Creek is of particular interest because of the climatic implications. The indicated climate is quite in keeping with the postulated requirements of the dominant species in the Thorn Creek flora.

Except for Kirkham's collections from Linson Valley (18), there has been no definite record of *S. affinis* from southwestern Idaho or eastern Oregon. Lindgren (26) did, however, mention two species as "*Sequoia* sp. like *S. gigantea*" from Sucker Creek, Oregon. Neither figures nor descriptions were given so it is impossible to express any opinion as to their similarity to the Thorn Creek specimens.

Sequoia Langsdorfi (Brongn.) Heer. Plate 2, fig. 1. A few small, deciduous, lateral branches like those of the coast redwood, *Sequoia sempervirens* Endl. were found. One has a small bud at the end and shows clearly the smaller leaves characteristic of the base of a branchlet. At the present time the redwood is confined to a narrow belt on the western slope of the Coast Ranges of California. *Sequoia* had a wide distribution in the early Tertiary and is quite abundant in such formations as the Bridge Creek. The progressive aridity and greater temperature differences in later Miocene times greatly restricted its range and only a few scattered areas indicate its wider extent then and during the Pliocene. Because of the extreme sensitivity of the living species to environmental conditions, *Sequoia* is taken to be a good indicator of past climates. It was apparently rare in southwestern Idaho and eastern Oregon during Miocene and early Pliocene times. Such specimens as remained in the Thorn Creek flora were probably a few survivors in favored locations.

Thuja Garmani Lesq. Plate 2, fig. 7. Three small specimens are assigned

to this species. It is difficult to distinguish *Thuja* from *Chamaecyparis* on the basis of leafy shoots alone. The reference of these specimens to *T. Garmani* is based upon their similarity to *T. plicata* D. Don and to the fossil from Weiser, Idaho, figured as *T. Garmani* by Dorf (16).

The western red cedar ranges from sea level to elevations of 6000 feet along the western side of the continental divide in the northern states. It occurs widely in swamps in the Olympic region of Washington and singly and in small groves from Alaska to northern California. *T. Garmani* might almost equally well be considered similar to *T. occidentalis* L., the white cedar or arbor-vitae, of the northeastern United States and Appalachian region.

Salicaceae

Populus Booneana n. sp. Plate 2, figs. 14, 15. Leaves suborbicular with a short acuminate apex; base broadly cuneate; margin crenate; the rounded teeth usually pointing outward; midrib straight or flexuous; secondaries 4-6 pairs, usually alternate, some intermediates present; lowest secondaries giving off 4 or 5 abaxial veins, some of which fork as do the secondaries; tertiary venation irregular; ultimate venation a coarse reticulum; texture membranaceous. Type no. 21462 U. M.

This species is characterized by the almost round shape and the short acuminate apex of the leaf. Three principal veins arise from the top of the petiole but two additional weak ones may be present.

Of the living species studied, *P. rotundifolia* from the Himalayas is quite similar. Among American species, *P. tremuloides* is most like the fossil. The quaking aspen is common in the mountains of Idaho and was found growing along Thorn Creek. It is frequent in the higher elevations and colder regions of North America.

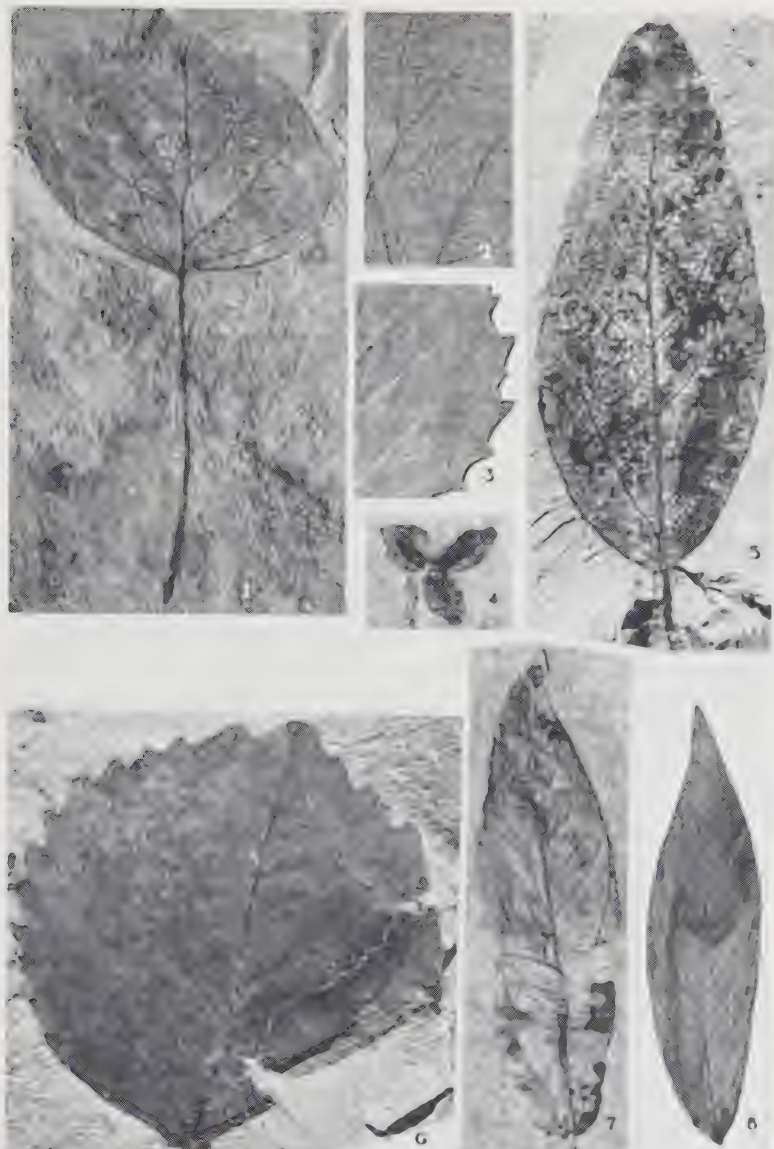
This species is named in honor of the late Dr. W. J. Boone of the College of Idaho, a pioneer botanist of Idaho.

Populus dolichophylla n. sp. Plate 3, fig. 5; plate 4, figs. 1, 2, 4. Leaves ovate-lanceolate to narrowly lanceolate, 3.5-9 cm. long, 1-3.5 cm. wide, widest in the lowest third and narrowing to a long acuminate apex and narrow cuneate base; margin finely and regularly crenate-serrate except at the entire base; teeth small, forward pointing; midrib moderately stout, often flexuous or curved; secondaries thin, alternate, over seven pairs, those in the extreme upper part of the blade indistinct, all arching upward near the margin, often giving off adaxial tertiaries that form loops with the next secondaries above, some, especially the lowest pair, giving off a few abaxial tertiaries which extend out to end in arches just within the margin; tertiary venation consisting of some percurrent tertiaries almost perpendicular to the midrib; ultimate venation an irregular reticulum. Type no. 21459 U. M.

The leaves which Knowlton (21) figured and described as *Celastrus Lindgreni* from the type Payette formation appear to be this species.

P. dolichophylla is another Thorn Creek fossil species which has its supposed living representative still growing in that locality. *P. angustifolia* James

PLATE 3



Figs. 1, 2, 6. *Populus washoensis* Brown. Fig. 3. Portion of leaf of *P. grandidentata* Michx. for comparison of venation with that of *P. washoensis*. Fig. 4. Capsule of *Populus extremuloides* Knowlt. Fig. 5. *Populus dolichophylla* n. sp. Fig. 7. *Salix venosiuscula* n. sp. Type no. 21464 U. M. Fig. 8. *Salix Fendleriana* Anders. from Gunnison County, Colo., Univ. of Mich. Herb.

(Plate 4, fig. 3), the narrow-leaf cotton wood, has essentially the same type of leaves and is abundant along Thorn Creek. It, like the fossil species, is characterised by the cuneate base, the small crenate teeth which are absent only from the basal region, the long ovate-lanceolate shape and secondaries that in the main part of the blade are essentially equal in strength. *P. angustifolia* grows along the banks of streams usually at fairly high altitudes and is the common cottonwood of the Rocky Mountain states. The fossil leaves also show some resemblance to *P. acuminata* Rydb., the lance-leaved cottonwood found along streams in the dry foothill region of the eastern side of the Rocky Mountains from Alberta to western New Mexico. This species has leaves that are relatively broader and shorter and have more prominent teeth than the Thorn Creek fossils.

Populus eotremuloides Knowlt. Plate 3, fig. 4; plate 4, fig. 7. Knowlton described this species from beds of the Payette formation southeast of the old Marsh (Montour) post office, Gem County, Idaho. It has since been reported from a number of western Miocene localities.

As has been previously suggested, it resembles the cottonwoods *P. balsamifera* L. and *P. trichocarpa* T. & G. The scanty Sucker Creek material in my collection was considered to be very much like the former (33), whereas the Thorn Creek leaves are clearly more like *P. trichocarpa*. These fossils exhibit a considerable variation, but the character of the fine venation and the regular spacing of the secondaries is constant throughout. The major variation occurs in shape, which may be rhombic-lanceolate to broadly ovate or even slightly cordate. This change in shape is, of course, matched by a variation in the base from narrowly cuneate to cordate. There is indication of a difference in texture, the narrow leaves being apparently very thin and having a distinct, fine venation; the broad ones appearing to be subcoriaceous with fairly obscure venation. While this range of variation is somewhat greater than that indicated by the illustrations of the species in some recent publications, it is no greater than that indicated in the poplar leaves of the cottonwood type described by Knowlton from the Payette formation. Neither is it any greater than the variation which I observed on a single tree of *P. trichocarpa* at Lake Crescent, Clallam County, Washington. This cottonwood is found in the Coast Ranges from Alaska to southern California and is said to be the commonest tree along the streams of the Continental Divide in Idaho and Montana.

Populus washoensis Brown. Plate 3, fig. 1, 2, 6. Recent collections have increased the number of specimens of this species considerably. They show much more variation than the few original impressions. The teeth on one leaf are somewhat small and quite curved, but the shape and venation are typical. Two specimens are very much like some of the smaller leaves described and illustrated as *P. heteromorpha* Knowlt. (23) and since transferred to *Cebatha*. These leaves are almost identical with certain leaves of *P. alba* L. and *P. canescens* Smith. The majority of the leaves find their greatest similarity among living species with *P. grandidentata* Michx. (Plate 3, fig. 3), the large-toothed aspen of the eastern United States. The small leaves are probably merely variants.

PLATE 4



Figs. 1, 2, 4. *Populus dolichophylla* n. sp. Fig. 4 type, no. 21459 U. M. Fig. 3. *Populus angustifolia* James from Winnemucca, Nev., in Univ. of Mich. Herb. Fig. 5. *Alnus corrallina* Lesq. Fig. 6. *Salix venosiuscula* n. sp. Fig. 7. Detail of venation of *Populus eotremuloides* Knowlt. Fig. 8. *Salix boisiensis* n. sp. Figs. 9, 10, *Salix spokanensis* (Berry) Brown.

Salix boisiensis n. sp. Plate 2, fig. 3; plate 4, fig. 8. Leaves oblong-obovate, 3.2-3.8 cm. long, 1.7 cm. broad; apex rounded; base unevenly cuneate; margin entire; midrib stout, prominent to the apex; prominent secondaries about 12 pairs, often with an additional single intermediate vein between adjacent major secondaries, secondaries arising from the midrib at angles of $70-75^{\circ}$ near the base, $55-70^{\circ}$ near the middle of the blade and $30-40^{\circ}$ at the apex; tertiaries forming an irregular coarse reticulum; petiole 7 mm. or more in length, curved on the only specimen in which it is preserved; texture thin but firm. Type no. 21466 U. M.

These leaves may be matched with surprising exactness by leaves of *S. delnortensis* Schneider (specimens from Smith River, Calif., in the University of Michigan Herbarium). They are also almost equally like *S. Scouleriana* Barr., the black willow, found growing along Thorn Creek. Its range extends from Alaska to northern California and to the eastern ranges of the Rocky Mountains.

The fossils are also very similar to variants of a number of species of *Salix*. Such variants are decidedly in the minority and are not satisfactory for comparison with fossils unless the range of variation exhibited by the living species is also encountered in the fossils. Such is not the case in the willow leaves from the Thorn Creek bed. Leaves of none of the other three recognised fossil species resemble the normal leaves of those species in which a few varying leaves seem to be similar to *S. boisiensis*.

The problem of the best disposition to be made of species of *Salix* is a complex one. It, like the study of fossil leaves of *Quercus*, is complicated by the unsatisfactory diagnosis of species by leaf characters alone, and by the disagreement among taxonomists as to the identification of species. At the risk of indicating too many species, I feel that it best to recognise four species of *Salix* in the Thorn Creek collection since this seems to give the most exact picture of the diversity of willows encountered. In a modern flora so many leaf forms would indicate several different types even if some intermediates were present.

Salix Schimperii Lesq. Plate 5, fig. 1. Leaves of this species are among the most numerous in the collection. Because of the length of the leaves and the prevalent checking and breaking of the matrix there are no perfect specimens. They bear a close resemblance to the common heart-leaved willow, *S. cordata* Muhl. (Plate 5, fig. 2).

Salix spokaneensis (Berry) Brown. Plate 4, figs. 9, 10. There are several easily recognisable leaves of this species. They are remarkably uniform in shape and size, the smallest is 1.3 by 2.9 cm. and the largest 1.3 by 3.4 cm. Berry (5) described the species as *Rhamnus* from the Latah at Spokane, Washington and the Thorn Creek specimens appear to be almost identical with his figures. A careful study of the available herbarium material did not show any species of *Rhamnus* with consistently small leaves. However, there is an undeniable resemblance to certain small leaves of *R. cathartica* L., the european buckthorn.

Brown (10, p. 168) transferred this species to *Salix*. I feel that the reasons for this transfer are not much better than the reasons for retaining it in *Rham-*

PLATE 5

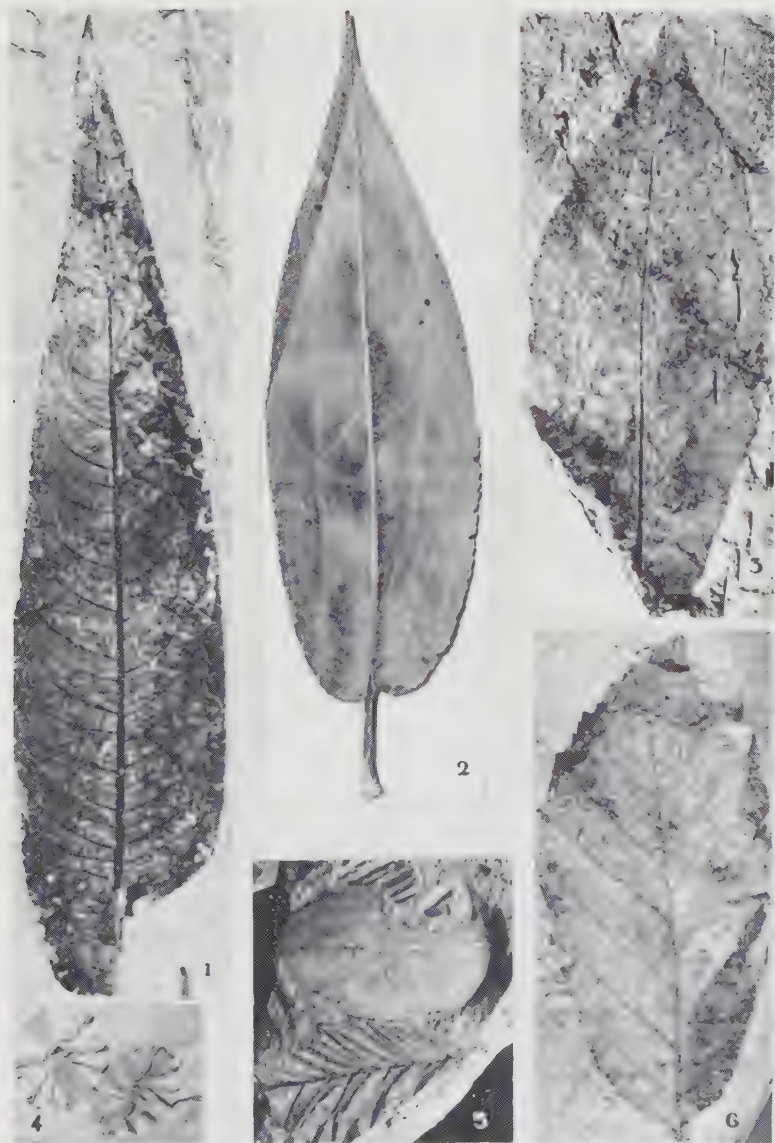


Fig. 1. *Salix Schimper* Lesq. $\times 3/4$. Fig. 2. *Salix cordata* Muhl. from Watersmeet, Mich., in Herb., Univ. of Mich. Fig. 3. *Carya egregia* (Lesq.) LaMotte. Fig. 4. *Alnus* sp. cones. Fig. 5. *Carya pecanoides* (Chaney) n. comb. Fig. 6. *Alnus corrallina* Lesq.

nus, but am, nevertheless, following his change. It is probable that this species does not belong in either genus and it may really belong, as Brown suggested, in *Lonicera*. His figure of *Salix commutata denudata* Bebb. does show venation essentially like that of the fossil, but it does not, and neither to the herbarium specimens available to me, give any indication of the basal teeth said to be on the Latah specimens.

S. commutata var. *denudata* is a plant of alpine and subalpine bogs and there is little likelihood that it is really the nearest of kin to the Thorn Creek specimens even if they are correctly placed in *Salix*.

Salix venosiuscula n. sp. Plate 3, fig. 7; plate 4, fig. 6. Leaves membranaceous, narrow elliptic or very slightly obovate, rather small, 5.8 cm. long, 1.3-1.6 cm. wide; margin finely and regularly serrate; apex acute; base rounded; secondaries distinct but slender, irregular in spacing, about 13-15 pairs, arising at an angle of about 40° and curving upward near the margin; intermediates few; finer venation a coarse, irregular, rather prominent reticulum; petiole stout, at least 1 cm. long. Type no. 21464 U. M.

The living *S. Fendleriana* Anders (Plate 3, fig. 8) has leaves that are quite similar. This is a small shrub or tree of the submontane and montane zones. It is common in the Rocky Mountains of the United States. *S. lasiandra* Benth. also has leaves similar to the fossil and is often considered to include *S. Fendleriana* as a variety, or even as an inseparable phase.

Juglandaceae

Carya egregia (Lesq.) LaMotte. Plate 5, fig. 3. The two fragmentary leaflets are smaller and more delicate in appearance than those LaMotte (24) illustrated from the Upper Cedarville formation, but are similar in the essential characters of shape and venation.

I have not felt justified in associating these leaflets with the pecan fruit treated below because pecan leaflets in the living types are distinctive by their narrow and somewhat falcate form. At isolated localities for typical hickory in Mexico a pecan grows in the same habitat. Likewise, pecans and hickories are such common associates in the United States that it is not necessary to consider the leaflets and the nut in the Thorn Creek bed as necessarily conspecific. If both were so scarce as to leave a numerically almost negligible record in the deposit, it might easily be that one would be represented only by foliage and the other by fruit.

Carya pecanoides (Chaney) n. comb. Plate 5, fig. 5. A species of pecan was described as *Hicoria pecanoides* from the Eagle Creek flora. Although this Thorn Creek specimen may not represent the same species it is referred to it as I feel that there are no sufficiently definite distinguishing characters for fossils of this type.

Betulaceae

Carpinus payettensis n. sp. Plate 7, fig. 4. Involucre leaf-like, 3-lobed, the main lobe much longer than the lateral ones; main lobe with 3 coarse teeth on each side, upper pair opposite, very long and narrow, each tooth entered

PLATE 6



Figs 1, 2, 4. *Castanopsis angustifolia* n. sp. Fig. 4. Type, no. 21474 U. M. Fig. 3. *Castanopsis chrysophylla* (Hook.) DC. from Hood River, Ore., in Herb., Univ. of Mich. Fig. 5. *Alnus carpinoides* Lesq. Fig. 6. *Betula lacustris* MacG.

by a distinct vein from the midrib from point of attachment of involucre; lateral lobes apparently not over 1.2 cm., middle lobe 2.6 cm. (estimated). Type no. 21470 U. M.

A single specimen and its counterpart appear to represent an involucre of *Carpinus*. Although the nut is lacking there can be little doubt as to the correctness of this identification. Both the coarse and fine venation have exactly the same aspect as the venation of the involucre of *Carpinus caroliniana* Walt. (Plate 7, fig. 3), the common eastern blue beech or hornbeam. The strong marginal teeth and the stout veins entering the lower lobes and teeth directly from the point of attachment are also suggestive of that species. On the other hand, the rather narrow and quite elongate middle lobe is more suggestive of *C. Betulus* L. It is unfortunate and rather surprising that no leaves of *Carpinus* have been recognized in this collection.

Betula lacustris MacG. Plate 6, fig. 6. The Thorn Creek specimens are very similar to the figured type of this species from Trout Creek (28). The leaves are characterized by being ovate, membranaceous and coarsely serrate except at the base. *B. papyrifera* var. *occidentalis* is somewhat similar but *B. fontinalis* is probably the nearest ally. The latter grows along stream banks throughout the mountain areas of the West. At Thorn Creek it is abundant as a low shrub-like tree.

Alnus carpinoides Lesq. Plate 6, fig. 5. This extremely abundant and variable Miocene alder is represented in the Thorn Creek collection by only a few specimens. These are quite similar to the leaves of *A. sinuata* (Regel) Rydb. which is found from Alaska through the Coast Ranges and Rocky Mountains.

Alnus corrallina Lesq. Plate 4, fig. 5; plate 5, fig. 6. This common Miocene *Alnus*, rare, like the preceding, at Thorn Creek, appears to be most like the living *A. rhombifolia* Nutt. and *A. rugosa* K. Koch. Certain specimens of the latter are very similar to the fossil except for their greater width and tendency toward obovateness. Aments probably similar to this living species have also been found. On the whole, *A. rhombifolia* seems to come the nearest to duplicating the Miocene species. This white alder grows in northern Idaho and extends to the eastern slope of the Cascade Mountains in Washington and Oregon. In California it is found in the major mountain chains.

Alnus sp. Aments. Plate 5, fig. 4. Aments apparently similar to those of *A. rugosa* are included in the collection but are not assigned to either of the two leaf species of *Alnus*.

Fagaceae

Fagus pacifica Chaney. Plate 11, fig. 5 (*F. washoensis* LaMotte, Carnegie Inst. Wash. Pub. 455:119, pl. 8, figs. 2, 3, 5. 1936. *Castanea Lesquereuxi* LaMotte, Carnegie Inst. Wash. Pub. 455:130, pl. 9, figs. 4, 5. 1936.)

Since my preliminary report (34) on this flora was written further studies have been made of the variation to be found in the living American species of *Fagus*. Also more fossils have been collected. These studies have confirmed my previous suggestion that there is some doubt whether two species of beech have been found in the western Miocene. With the series of fossil and com-

PLATE 7



Fig. 1. *Quercus pseudolyrata* Lesq. Figs. 2, 6. *Quercus clarnensis* Chaney. Fig. 3. *Carpinus caroliniana* Walt. (bract) from Washtenaw Co., Mich. in Herb., Univ. of Mich. Fig. 4. *Carpinus payettensis* n. sp. No. 21470, U. M. Fig. 5. *Quercus Browni* Brooks.

parable living leaves now at hand, I do not believe that *F. washoensis* can be maintained as distinct from *F. pacifica*. In fact, I would even go so far as to suggest that all the western Miocene leaves referred to *Fagus* should be referred to a single species. If this were done the name would have to be *F. sanctieu-geniensis* Hollick on the basis of priority.

F. pacifica was described from material collected on Gray's ranch in the Crooked River Basin, Oregon. As only seven leaf impressions were included in that collection the complete range of variation was not evident. Two of the three figured leaves are, according to the evidence from Thorn Creek, not to be regarded as really typical of the species. They can, however, as Chaney (14) pointed out, be duplicated by some leaves of the living *F. grandifolia* Ehrh. Living counterparts, for instance, were collected by the writer in the Great Smoky Mountains of Tennessee. About a half dozen similar leaves have been noted in the Thorn Creek collection, among much more numerous leaves of a more typical form.

F. washoensis was based on collections from 49 Camp, Nevada and Pit River, California. LaMotte compared his specimens with the Asiatic beech, *F. longipetiolata* Seeman. No specimens of that species are available to the present author, but the figures given by LaMotte (24) for comparison differ strikingly in marginal characters from the fossil material which he illustrates. In the living species the margin dips in at the ends of the secondaries forming an undulate margin, in the fossils, both as described and illustrated, the margin is dentate or serrate with triangular teeth terminating the secondaries. These leaves, to judge from the illustrations, are readily matched by leaves of *F. grandifolia* which I collected in Tennessee.

Several minor differences have been noted between these supposedly distinct fossil species, but to my mind they all break down when a large amount of material is examined. The occurrence in the western Miocene of a single species of *Fagus* of eastern American aspect is quite in keeping with expectation when the relationship of the floras is considered.

F. pacifica was an important constituent of the Miocene forests. It has been reported from the Crooked River Basin, Tipton and Austin, Oregon; the Latah of northern Idaho and eastern Washington; Sucker Creek, Idaho; the Upper Cedarville at 49 Camp, Nevada and Pit River, California. It is very abundant at Thorn Creek where it is second in numerical importance.

The American beech is important in the climax deciduous forest of eastern America.

Castanopsis angustifolia n. sp. Plate 6, figs. 1, 2, 4. Leaves subcoriaceous, narrowly elliptic or lanceolate, up to 6 cm. long, 2 cm. wide, narrowing equally from the widest point about the middle to the acuminate apex and slightly cuneate base; midrib not conspicuous; secondaries weak, closely set, almost parallel, subopposite, about 14-16 pairs, ending near the margin or occasionally bending upward just within the margin; finer venation a fairly fine, mostly quadrangular reticulum with a few weak percurrent tertiaries; margin entire, at times very slightly undulate; petiole stout. Type no. 21474 U. M.

PLATE 8



Fig. 1. *Quercus Maccanni* Berry. Fig. 2. *Quercus Eoprinus* Smith. Fig. 3. *Quercus Merriami* Knowlt. Fig. 4. *Quercus deflexiloba* n. sp. Type, no. 21496 U. M.

Three species of *Castanopsis* have been described from the western Miocene. Lesquereux described *C. chrysophylloides* from Chalk Bluffs, Nevada County, California, and Dorf has since reported it from the Pliocene of California. Brooks (9) has transferred certain species previously referred to *Quercus* to this genus as *C. convexa* and *C. consimilis*. Of these three, the first is the most similar to the Thorn Creek specimens, but as illustrated, is, nevertheless, quite distinct in shape and venation.

C. angustifolia leaves are very much like the narrow, linear-lanceolate ones of the living *C. chrysophylla* DC. (Plate 6, fig. 3). *Castanopsis* is a genus that is found mostly in Asia. It is represented in North America by only two species confined to the Pacific Coast.

Quercus pseudolyrata Lesq. Plate 7, fig. 1. This characteristic species of black oak is well represented at Thorn Creek. *Q. Merriami*, which is somewhat similar, differs in having more oblique sinuses, more tapering lobes and scarcely any tendency toward secondary lobing.

The most similar living species is usually considered to be the California black oak, *Q. Kelloggi*, and the nearest eastern equivalent is *Q. velutina*.

Quercus Merriami Knowlt. Plate 8, fig. 3. Recent collections yielded several excellent impressions of this species which I (34) have previously reported.

Quercus deflexiloba n. sp. Plate 8, fig. 4. Leaf thin, broadly elliptic, deeply lobed; sinuses very narrow, ultimately nearly parallel-sided and rounded, extending $\frac{1}{2}$ to $\frac{3}{4}$ the distance to the midrib, directed almost perpendicularly to the midrib; lobes 4 or 5 on a side, scarcely tapering, sharp-pointed or broadly tridentate, the central tooth longer than the others and separated from them by a broad, shallow, rounded sinus; principal secondaries with a sigmoid flexure terminating in the apices of the lobes, arising at an acute angle, immediately bending outward and again inward to enter the lobes; intermediate secondaries 2-3 between principal ones, usually weak, soon obscure, but a few giving off weak branches; principal secondaries giving off numerous pinnate veins which may extend to the margin of the lobes; finer venation irregular; base and apex imperfect. Type no. 21596 U. M.

Although this is obviously an oak no living species so far studied has the same combination of characters. *Q. Catesbaei* does, in some specimens, have the same type of tridentate lobes. Since the fossil is unlike any of the other fossils it is considered to be a different species even though it is possible that it may represent merely a variation of another type.

Quercus simulata Knowlton. Plate 9, fig. 7. Small leaves of the general type of this species are abundant in many western Miocene beds and opinions about their relationships are varied. *Q. hypoleuca* Engelm. from the southwest and northern Mexico appears to be the nearest living equivalent among American oaks.

Quercus clarnensis Trel. Plate 7, figs. 2, 6; plate 9, fig. 3; plate 11, fig. 4.

PLATE 9



Fig. 1. *Quercus Muchlenbergii* Engelm. var. *Brayi* Sarg. from Guadalupe Peak, Texas, in Herb., Univ. of Mich. Figs. 2, 6. *Quercus payettensis* Knowlt. Fig. 3. *Quercus clarnensis* Chaney. Fig. 4. Staminate catkin? Fig. 5. *Quercus Bretzi* Chaney. Fig. 7. *Quercus simulata* Knowlt.

This is the most abundant species in the Bridge Creek flora of the Crooked River Basin of Oregon and Chaney has also reported it from the Payette formation. It is well represented at Thorn Creek. The leaf impressions from Thorn Creek exhibit a wide range in variation and were at first considered to belong to two species. However, when a series was studied no constant differences between two "species" could be detected and the leaves are all grouped as *Q. clarnensis*. As illustrated and described by Chaney (14) the Bridge Creek specimens have as great a range of variation as these from Idaho. No closely related living species has been suggested.

Quercus Browni Brooks. Plate 7, fig. 5. A few leaves relatively shorter and broader than those above may be assigned to *Q. Browni*. The teeth are blunter than those on the leaves from Sucker Creek. Leaves of this species are seldom more than $2\frac{1}{2}$ times as long as they are broad. The nearest living equivalent seems to be *Q. chrysolepis* Leibm., a live oak of the California Coast Ranges.

Quercus Tuckeri n. sp. Plate 10, figs. 6-8. Leaves firm, narrowly elliptic or slightly obovate, 5-5.5 cm. long, 1.5-2.7 cm. wide, lobed; base narrowly cuneate; apex acute to obtusely rounded; margin shallowly round-lobed, lobes 2-4 (generally 3 or 4) pairs, usually approximately equal in size; sinuses shallow, angled or abruptly rounded, usually directed downwardly; midrib moderately stout; secondaries 9-10 pairs, those terminating in the ends of the lobes usually a little stronger than the others, the one or two pairs of intermediate secondaries between the lobes go to or just above the sinuses, those arising in the upper part of the blade above the lobes arch to form loops; tertiaries thin, leaving the secondaries at right angles, percurrent between the secondaries or in the lobes often forming loops with adjacent tertiaries just within the margin. Type no. 21480 U. M.

Q. Tuckeri is readily distinguishable from *Q. payettensis* Knowlton by its rounded lobes, the intermediate secondaries and the presence of distinct tertiaries. *Q. columbiana* Chaney from Eagle Creek and the Latah of northern Idaho is larger, has more lobes and a somewhat different type of venation. Chaney's figure 2, plate 13 (12) appears to be a leaf of the type here included as *Q. payettensis*.

Among living species the shin oak, *Q. breviloba* (Torr.) Sarg., has many of the same characteristics. The venation and form of the lobes of the fossil (but not the shape of the leaf) are strikingly like those of var. *argentata* figured by Trelease (37, Pl. 170). The species is characterized by the elliptic-oblancoate to obovate-undulate or shallowly round-lobed leaves. It grows in the eastern Sierra Madre region of Mexico and in Texas.

Quercus boisiensis n. sp. Plate 10, figs. 1, 4. Leaves thin, length unknown, the largest preserved for 7.3 cm. which appears to be a little over half the normal length, 3.3 cm. wide; apparently narrowly obovate or narrowly elliptic in shape, lobed; lobes rounded, almost at right angles to the midrib, sinuses shallow, rather narrow; midrib broad, secondaries more than 10 pairs, arising at angles of 55 to 60° , those terminating in the lobes slightly stronger than

PLATE 10



Figs. 1, 4. *Quercus boisiensis* n. sp. Fig. 1 type, no. 21484 U. M. Fig. 2. *Ulmus paucidentata* Smith. Fig. 3. *U. racemosa* Thomas from St. Clair Co., Mich., in Herb., Univ. of Mich. Fig. 5. *Ceanothus* sp. Figs. 6-8. *Quercus Tuckeri* n. sp. Fig. 8 type, no. 21480 U. M.

the others; tertiaries fine, often almost parallel; base moderately broad, distantly auricled or subcordate; petiole stout, 5 mm. long. Type no. 21484 U. M.

This species exhibits many features found in two European oaks, *Q. Robur* and *Q. conferta* Kit. The fossils seem to be even more like *Q. Eastwoodii* Rydb. as illustrated by Trelease (37, pl. 162) in which the leaves are obovate, the sinuses nearly closed and the lobes numerous and crenate. This living species is known only from the southern Rocky Mountain region of Utah.

Quercus Bretzi Chaney. Plate 9, fig. 5; plate 11, figs. 1, 2. A number of excellent specimens of this oak were found during the collecting season in 1939 although none had been found before. Chaney (12) described it from Eagle Creek and Brown (11) has since recognized it in the Latah flora from Spokane, Washington.

This species does not seem to have an exact counterpart in the modern flora, but its leaves are somewhat like those of *Q. bicolor* Willd., the swamp chestnut oak of the northeastern states. The lobes of the fossil leaves are fewer in number and correspondingly larger in proportion to the whole leaf than in the eastern analogue. The outline is also more markedly obovate.

Quercus Maccanni Berry. Plate 8, fig. 1. Since this species has been previously discussed (Smith, 34) no comments are included now.

Quercus Eoprinus Smith. Plate 8, fig. 2; plate 12, fig. 7, plate 14, fig. 7. Additional collections have only served to demonstrate more fully the dominance of this species in the Thorn Creek flora. A few more specimens are illustrated to indicate the variation to be found in the leaves. As I previously suggested the fossils may be readily duplicated by specimens of *Q. montana* Michx. (*Q. Prinus* Auct.) collected in Tennessee.

The leaves of *Q. resinosa* Liebm. from the western Sierra Madre region of Mexico, although much larger, are, as illustrated by Trelease (37, plate 68), strikingly similar and the fine venation is even more like that of the fossils than is that of *Q. montana*. Unfortunately no herbarium material is available for more accurate comparison. Both of the living species mentioned have larger leaves than the fossil and this is particularly true for the Mexican species, a point in favor of regarding *Q. montana* as the closest ally of *Q. Eoprinus*.

Quercus payettensis Knowlt. Plate 9, figs. 2, 6. Leaves thin, firm, narrowly elliptic to obovate, up to 7 cm. long and 3.2 cm. wide, lobed; lobes 3-7 or more pairs, subopposite or alternate, simple, triangular or slightly oblique, rather sharply pointed at apex but apparently not bristle tipped; sinuses shallow, rounded, extending no further than one-third the distance to the midrib; base narrow to round cuneate; apex acute; midrib moderately stout below, straight or slightly curved; secondaries as many as there are lobes, each entering a lobe and terminating in its apex, subopposite, never forking, arising at angles of 18 to 35°; no visible tertiaries; ultimate venation often well preserved, forming a rather fine, regularly quadrangular reticulum.

PLATE 11



Figs. 1, 2. *Quercus Bretzi* Chaney. Fig. 3. *Rhamnus* sp. Fig. 4. *Quercus clarnensis* Chaney. Fig. 5. *Fagus pacifica* Chaney. Figs. 6, 7. *Pyrus heteromorpha* n. sp.

The principal characteristics of this species are the lanceolate or narrow obovate shape, the prominent small lobes and the entire absence of subordinate lobing. *Q. payettensis* was described from Jackass Creek, Boise County, Idaho, by Knowlton. He later recognized it in the Latah of northern Idaho. Because of the large amount of material available and the differences in interpretation of the species by various authors, a description based upon the Thorn Creek material identified as *Q. payettensis* is given above.

The distinction between certain specimens of this species and *Q. Merriami* is somewhat obscure. *Q. payettensis* is usually smaller, more lanceolate or obovate, with distinct deltoid lobes quite regularly spaced. In *Q. Merriami* the lobes are elongated, not so regularly spaced and the sinuses are considerably deeper and more oblique.

Q. payettensis is somewhat like *Q. infralutea* Trel. (Trelease 37, pl. 136) except that in the fossil the teeth are more prominent. This living species is known from the western Sierra Madre region of Mexico. According to Berry (8) the leaves of *Q. payettensis* from fossil localities in northern Idaho resemble those of *Q. Duraznillo pinetorum* Trel. from Mexico. The narrower leaves from Thorn Creek are almost like the northern Idaho fossils and differ from the Mexican species in that the secondaries extend clear to the ends of the simple lobes. The majority of the Thorn Creek specimens are obovate and have broader, more forwardly pointing teeth. The larger leaves resemble those of *Q. Brayi* Small which is often considered to be a variety of *Q. Muehlenbergii* Engelm. This variety of the chestnut oak grows in the southwestern and adjacent Rocky Mountain region of Texas and New Mexico. There is also marked resemblance between the narrower fossil leaves and the living *Q. lancifolia* Chamisso & Schlechtendal as figured by Trelease (37, pl. 32) except that this Mexican species has the leaves toothed only in the upper half. In spite of all these resemblances the fossils probably find their closest affinity with the American species, *Q. Muehlenbergii* (Plate 9, fig. 1). This chestnut oak is a common constituent of the deciduous climax forest of the eastern United States.

Ulmaceae

Ulmus paucidentata Smith. Plate 10, fig. 2; pl. 13, figs. 4, 9. Additional collections yielded a number of excellent specimens of this species. They serve principally to indicate that the elliptic shape is more common than the elliptic-ovate. The doubly or triply serrate nature of the margin is much more noticeable than in the type specimen. All the leaf impressions are decidedly unequal at the base, and in two impressions the base on one side is rounded instead of cuneate as is usual.

The winged seeds, suggestive of those of *U. racemosa* Thomas (Plate 10, fig. 3), may represent the seeds of this fossil species.

Magnoliaceae

Magnolia oregoniana Chaney. Plate 14, fig. 5. No additional specimens were obtained in recent collections so the species is, unfortunately, still poorly

PLATE 12



Fig. 1. *Cercocarpus cuneatus* Dorf. Fig. 2. *Fraxinus leptocarya* n. sp. Fig. 3. *F. quadrangulata* Michx. from Allentown, Mo., in Herb., Univ. of Mich. Figs. 4, 10. *Acer glabroides* Brown. Fig. 5. *Acer* sp. samara. Fig. 6. *Acer* sp. samara. Fig. 7. *Quercus Eoprinus* Smith. Figs. 8, 9. *Acer Scottiae* MacG.

represented in the Thorn Creek flora. The single specimen resembles *M. virginiana* L.

Rosaceae

Amelanchier dignata (Knowlt.) Brown. Plate 13, fig. 2. A single small leaf is referred to this species. It differs from most of the illustrated specimens in its smaller size, in the greater irregularity of the secondaries and in having teeth well below the middle of the blade.

Amelanchier suberrata n. sp. Plate 13, fig. 1. Leaves thin, orbicular or slightly longer than broad, 1.3-3 cm. wide, 1.8-3.5 cm. long; broadly obtuse above, but apex minutely short-acuminate by the small tooth at the end of the midrib; base broadly rounded; margin entire along the lower half, toothed above, teeth obtuse, pointing toward the apex; midrib stout, straight; secondaries 5-10 pairs, thin, forming a broad angle with the midrib, curving upward and entering the teeth or forking once to send branches to two teeth; secondaries in lower part of blade becoming extinct along the margin; tertiaries percurrent, almost perpendicular to the midrib; ultimate venation a very fine reticulum; petiole preserved for a distance of 2.2 cm. Type no. 21506 U. M.

The ovate-orbicular shape serves to distinguish this *Amelanchier* from the other western Tertiary species. Among living species, *A. elliptica* A. Nels. (Plate 13, fig. 7) has essentially the same characters as to shape, size and margin. The chief difference lies in the more acute angle at which the secondaries of the living species arise and in its more conspicuous coarse teeth. *A. elliptica* is a small, slender, tree-like shrub that usually grows scattered in wet open places in the mountains of Colorado, Wyoming and Utah.

A. serrata differs from *A. dignata* in its shorter teeth, more definite tertiary venation and more nearly round leaf shape. It is possible that a good series of specimens would show an intergradation between these two and would indicate that they belong to the same species.

Cercocarpus cuneatus Dorf. Plate 12, fig. 1. Dorf described this species from the Pliocene of California and Axelrod recognized it in the Mt. Eden beds. The Thorn Creek leaves are somewhat narrower and appear to have been more coriaceous than those previously figured.

The living mountain mahogany, *C. montanus* Raf. (*C. parvifolia* Nutt.) is quite similar to the fossil. *Cercocarpus* is a North American genus confined to the dry interior and mountainous regions and to Santa Catalina Island. Two species are known to occur in the northern Rocky Mountains and the mountain mahogany is very common on the low hills of southwestern Idaho. It often forms the most conspicuous plant over considerable areas. It was not observed in the immediate vicinity of Thorn Creek but in all probability it does occur in the Boise Mountains.

Crataegus microcarpifolia Arnold. Two small leaves, the most complete of which is 3 cm. wide and 3.5 cm. long (estimated) appear to be indistinguishable, except in size, from *C. microcarpifolia* as illustrated by Arnold (3) from Trout Creek. These impressions are very similar to forms that have been

PLATE 13



Fig. 1. *Amelanchier suberrata* n. sp. Type, no. 21505 U. M. Fig. 2. *Amelanchier dignata* (Knowlt.) Brown. Fig. 3. *Symphoricarpos elegans* (Lesq.) Smith. Figs. 4, 9. *Ulmus paucidentata* Smith. Fig. 5. *Sapindus Drummondii* Hook. & Arn. from Rio Grande, Hidalgo Co., Texas, in Herb., Univ. of Mich. Fig. 6. *Sapindus idahoensis* n. sp. Type, no. 21517 U. M. Fig. 7. *Amelanchier elliptica* Nels. from Medicine Bow Natl. Forest, Wyo., in Herb., Univ. of Mich. Fig. 8. *Tilia parvulifolia* n. sp. Type, no. 21518 U. M. Fig. 10. *Prunus covea* Chaney.

referred to *C. Newberryi* Cockerell and may be indistinguishable from it. With the taxonomic confusion of living *Crataegus* a paleobotanist can hardly hope to do more than place fossils in the genus. Any comparison with living species is too unreliable to be worth very much. However, among living species studied, *C. pinnatifida* Bunge, although not an exact counterpart, is somewhat suggestive of these fossil leaves. This living species occurs in eastern Asia.

Prunus Chaneyi Condit. A single specimen is apparently indistinguishable from Condit's figure 3 (15, pl. 5) of *Prunus Chaneyi*. He described the species from material collected at several localities of the San Pablo formation of California. In his estimation *P. serotina* is the closest living ally. I fail to see a resemblance to the fossil in this living species but have no better suggestion or offer.

Prunus covea Chaney. Plate 13, fig. 10. The Thorn Creek fossils included under this name bear a closer resemblance to the figure of the living *P. emarginata* Walp., which Chaney (14, pl. 15, fig. 5) figured for comparison with *P. covea*, than to the illustrated fossils themselves.

Pyrus heteromorpha n. sp. Plate 11, figs. 6, 7; plate 14, fig. 6. Leaves lanceolate or narrowly lanceolate with one or more pairs of long basal lobes. The specimens available with one or at most two pairs of lobes; lowest lobes the largest, each entered by one major secondary near the middle and two minor ones near the margins; apex acute; margin at apex of leaf and of lobes serrate, otherwise entire; texture thin but apparently firm. Type no. 21504 U. M.

These impressions are suggestive of the Asiatic species *P. chinensis* as cultivated at the Michigan Botanical Gardens. They are also slightly similar to some species of *Crataegus*, but it is not possible to find a definite living analogue. The reference to *Pyrus* is made because that genus is more likely to include anomalous types showing the transition from simple to pinnate leaves than is *Crataegus*.

Meliaceae

Cedrela pteriformis (Berry) Brown. Plate 14, fig. 2. It is with considerable doubt that I refer this leaf to *Cedrela*. The reference is made because Brown (10) has so regarded Berry's figure of *Umbellularia dayana* from the Latah the figure of which so closely resembles the Thorn Creek leaf. It does not seem to be in keeping with the generic composition of this flora to find *Cedrela*, and I suspect that too many leaf-types are now being referred to that genus. No seeds identified as *Cedrela* have been found at Thorn Creek.

Aceraceae

Acer glabroides Brown. Plate 12, figs. 4, 10. The name used for this species is that suggested by Brown for those leaf impressions that are most similar to the western *A. glabrum*. Many of these have previously been referred to *A. Osmonti* which is comparable with the living *A. saccharinum* L. *A. Osmonti* in general has deep sinuses and fairly long narrow lobes.

Acer Scottiae MacG. Plate 12, figs. 8, 9. A few small leaves and a broken

PLATE 14

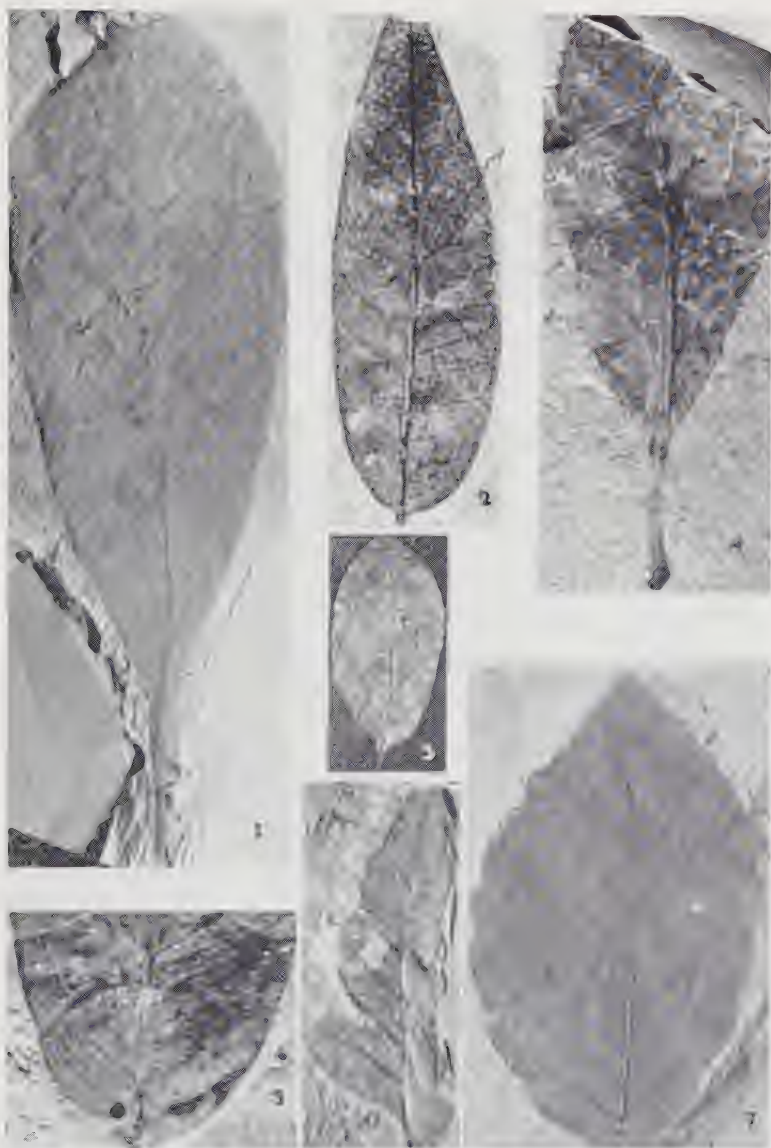


Fig. 1. *Arbutus opaca* n. sp. Type, no. 21519 U. M. Fig. 2. *Cedrela* ? *pteriformis* (Berry) Brown. Fig. 3. *Diospyros elliptica* Knowlt. Fig. 4. *Arbutus idahoensis* (Knowlt.) Brown. Fig. 5. *Magnolia oregoniana* Chaney $\times 1\frac{1}{2}$. Fig. 6. *Pyrus heteromorphia* n. sp. Fig. 7. *Quercus Eoprinus* Smith.

samara may represent this species although it is hard to explain the absence of any large leaves or fragments of large ones. MacGinitie described this maple from Trout Creek, Oregon, and it has since been reported from the beds at Weiser and south of Horseshoe Bend, Idaho, and from Sucker Creek, Oregon.

The leaves and samaras in this collection are suggestive of those of *A. pictum* Thunb. The samaras also resemble to some extent those of *A. circinatum* Pursh, but the nearest affinity to a living species is probably to one of the Asiatic types. The samaras are much like those of the European *A. campestre*, but this species has distinctive foliage totally unlike any of the fossil impressions.

Acer sp. samara. Plate 12, fig. 6. No living analogue nor closely similar species has as yet been located for this very beautifully preserved samara.

Acer sp. samara. Plate 12, fig. 5. No living analogue has been found for this samara which, like the preceding, is the only one of its kind in the collection.

Sapindaceae

Sapindus idahoensis n. sp. Plate 13, fig. 6. Leaves subcoriaceous, linear lanceolate, up to 9 cm. wide, 1.8 cm. wide, decidedly inequilateral but not falcate; apex long-acuminate; base unequal, narrowly cuneate on one side, slightly rounded on the other; midrib stout, tapering; secondaries thin, about 17 pairs, alternate, the basal ones on the cuneate side arising at angles of about 65° from the midrib; finer venation an obscure, irregular reticulum; margin undulate, slightly thickened; petiole 1.1 cm. long. Type no. 21517 U. M.

Because of the confusion existing between the genera *Sapindus* and *Cedrela* in the western fossil beds it is somewhat difficult to place this type of leaf correctly. A comparison of the living species of these two genera indicated that this fossil species is much more like a *Sapindus* than a *Cedrela* leaflet. Among previously illustrated fossils it is similar to *S. Dentoni* Lesq. and to some of the narrower leaves of *S. oregoniana* (transferred to *Cedrela* by Brown). *S. spokanensis*, reported from the Latah, is about the same shape and size, but judging by the illustrations it is not petiolate. The apparent living analogue for the Thorn Creek leaves is *S. Drummondii* (Plate 13, fig. 5) of the southwestern United States and northern Mexico.

Rhamnaceae

Rhamnus idahoensis Brown. The species was described from the beds at Salmon, Idaho, and since reported from the Latah of Washington. The single specimen is very similar to leaves of *R. Purshiana* DC. except for the narrower angles formed between the secondaries and midrib.

Rhamnus sp. Plate 11, fig. 3. The single leaf illustrated is the only one of the kind in the collection. No closely similar living equivalent has been found for it; but it is quite like some leaves of *R. cathartica* L. at the Michigan Botanical Gardens. Aberrant leaves of some species of *Prunus* are also somewhat similar. This would be a more logical living analogue than would be an European buckthorn. More material is necessary before anything other than conjecture is possible.

Ceanothus sp. Plate 10, fig. 5. The specimen illustrated, although broken, is quite suggestive of several species of *Ceanothus*. Because of its fragmentary condition no definite assignment to a living counterpart is attempted at this time.

Tiliaceae

Tilia parvulifolia n. sp. Plate 13, fig. 8. A single somewhat broken specimen and its counterpart appear to represent *Tilia*. It differs from LaMotte's specimens of *T. oregana* (24) in the fewer apparent secondaries which are also farther apart, in the lack of percurrent tertiaries, and in having coarser marginal teeth. The fragmentary nature of the material makes it impossible to be sure of the identification, but it is quite like several small-leaved species of *Tilia*. It is particularly like *T. floridans* of the southeastern United States.

Ericaceae

Arbutus idahoensis (Knowlt.) Brown. Plate 14, fig. 4. The Thorn Creek specimens, like those from Weiser, Idaho, are narrowly oblong, finely and regularly serrate, apparently quite thick with a stout midrib and numerous fairly conspicuous secondaries. In general aspect and venation this species is practically identical with *A. canariensis* L. It is more like this exotic species than any American type I have seen.

Arbutus opaca n. sp. Plate 14, fig. 1. Leaves coriaceous, narrowly obovate, narrowed gradually below to a long, slightly uneven base, the tissue of the blade decurrent on either side of the petiole for a distance of 1.8 cm. or more; blade rounded or acutish at the apex; margin entire; midrib stout, tapering, somewhat curved; secondary venation obscure, pinnate, secondaries very fine, 7 or more pairs arising at acute angles, somewhat sinuous, lost in the tissue of the blade before reaching the margin; finer venation an obscure irregular reticulum; length of largest specimen 6.8 cm. exclusive of the petiole; width 2.6 cm. Type 21519 U. M.

The more important characteristics of this species are the very obscure pinnate venation, lance-obovate shape and the extension of the blade along the petiole. These characters may all be duplicated in various species of *Arbutus*, but are not all evident in any one species so far studied. *A. Menziesii* Pursh often has the blade decurrent along the petiole, but its leaf is typically broadly oblong or ovate with a somewhat different type of venation. *A. arizonica* Sarg. and *A. texana* Buckl. conform somewhat better as to size and shape, but are usually widest below the middle. There is no indication of a wing on the petiole.

Two other species of *Arbutus*, *A. Matthesii* Chaney and *A. idahoensis* Brown, have been recognized in the western Miocene. Some authors do not differentiate between these two "species" but the specimens from Thorn Creek could scarcely be put in a single species. *A. idahoensis* appears to be a thicker leaf with quite prominent veins and a serrate margin. *A. Matthesii* is broader, may or may not be serrate and has its thin but distinct veins much farther apart than *A. opaca*.

Rhododendron idahoensis Smith. Leaves referred to this species are smaller than those of most living species of *Rhododendron*. The venation, however, appears to be similar and, until a more likely genetic reference becomes evident, the best disposition to be made of the fossils seems to be to retain them in *Rhododendron*. This genus is a not unlikely constituent of a floral assemblage like that of Thorn Creek. Species of this genus are found in the northeastern United States and Appalachian region and in the humid Pacific flora.

Ebenaceae

Diospyros elliptica Knowlt. Plate 14, fig. 3. The small leaf illustrated appears to represent this species as figured by Knowlton (22) from Van Horn's Ranch in the John Day Basin of Oregon. Among living species, *D. texana* Scheele, the black persimmon of western and southern Texas and Mexico, is quite similar.

Oleaceae

Fraxinus leptocarya n. sp. Plate 12, fig. 2. Samara 1.6 to 1.9 cm. long, 3 to 4.5 mm. wide at widest point just above the middle; narrowed abruptly to point of attachment, round acute at other end; seed obscure, extending a little over one third the length of the samara; wing with very fine close-set parallel veins, often with a sharp ridge or line along the middle. Type no. 21523 U. M.

A number of living species of *Fraxinus* have a similar type of samara with a compressed obscure seed. Among these may be mentioned *F. Lowelli* Sarg., *F. anomala* Torr., *F. Bungeana* DC. and *F. quadrangulata* Michx. (Plate 12, fig. 3). This last species, which is found throughout the eastern United States, is probably closest to the fossil.

Caprifoliaceae

Symphoricarpos elegans (Lesq.) Smith. Plate 13, fig. 3. Although it has not been found abundantly in any fossil bed of the lower Snake River Valley, this species is now known from the Sucker Creek, Weiser and Thorn Creek beds. The wide-spread living species, *S. racemosus* Michx., from which the fossil leaves are indistinguishable, is common in the Thorn Creek Valley. It grows as a low spreading shrub so would not be expected to be abundant in fossil beds.

FOSSILS OF UNCERTAIN TAXONOMIC POSITION

Unidentified cone. Plate 3, fig. 16. This cone is quite suggestive of those of *Sequoia gigantea*, but the stem on which it is borne is remarkable. It is irregular and apparently bears numerous scars of leaves or branches.

Unidentified seed. Plate 2, fig. 10.

Unidentified catkin. Plate 9, fig. 4. Probably betulaceous.

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